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"ELECTRICAL REVIEW."

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THE

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POOLING THE GERMAN ELECTRICAL INDUSTRY.

THE first prominent step in the direction of establishing a community of interests or a syndication of the German electrical industry is now being taken in that country, and as the subject is of considerable importance to the Fatherland and of a certain significance to the British trade, it deserves attention in these columns at the present moment. As has been stated in this journal, under the heading of the "Continental Electrical Industry," endeavours have been put forth during the past 18 months in order to bring about either a working agreement or an amalgamation of the Allgemeine Electricitäts Gesellshaft and the Schuckert Co., but, notwithstanding protracted negotiations, it has been found impossible for the directors to arrive at any understanding which would allow of a scheme of some kind or other being carried into effect. It has also been reported under the same heading that failing an agreement with the Schuckert Co., the voice of rumour had credited the Allgemeine Co. with the intention of trying to make an arrangement with the Union Electricity Co. Dame Rumour has in this case proved to be correct, and the directors of the A.E.G. are doubtless congratulating themselves upon the fact that the initial stage has been reached which they, and in particular Herr E. Rathenau, have striven to attain for several years past. The principal object which has been aimed at has not been a general amalgamation of the leading electrical firms in the form of a trust, but rather the establishment of working agreements between the different companies in some manner or other whereby competition would be avoided, the working expenses reduced, the cost of preparing schemes diminished, and the general interests of the associated firms promoted in the various markets. It is a comprehensive programme, which is calculated to considerably strengthen the German electrical industry in the world's markets; but, as already mentioned, the first step has only now been taken. Nevertheless, it may not require a similar period of several years to complete the remaining stages towards consolidating the trade.

It may be well to recall the fact that the A.E.G. was originally formed in 1883 under the title of the German Edison Co., this being abandoned for its present style in 1887. The company has a share capital of £3,000,000, and bonds or obligations amounting to £1,430,000, and its so-called trust is the Bank for Electrical Enterprises, of Zurich. The Union Electricity Co., which was constituted in 1892, owes its origin to the well-known Ludwig Loewe group, and it is the holder of the Thomson-Houston patents for Germany and various other European countries. It has a share capital of £1,200,000, and a bond issue of £500,000, and has as its trust the Company for Electrical Enterprises, although the latter has issued the whole of its share and other capital without it

being necessary for the former to participate in it. These details having been thus set forth, it is now necessary to refer to the arrangement which has just been approved by the boards of directors and supervision of the two companies, and which in a short time will be submitted for the endorsement of the shareholders of the two concerns. The agreement provides, in the first place, that the directors of the one company shall have a seat on the board of the other company and *vice versâ*, but each undertaking retains its board of supervision, and in certain cases the two boards will meet for the consideration of questions of which no information is at present forthcoming, and their decisions will be binding upon the two companies. Secondly, each company will continue to draw up its balance-sheet in its usual form, thus apparently leading to the conclusion that each is free to determine what it will place to reserve and other funds and the amount available for distribution as profits. In the third place, the net profits of the two enterprises will be lumped together, and the total divided between the two in the proportion of $\frac{1}{3}$ths to the A.E.G. and $\frac{2}{3}$ths to the Union Co., or in the ratio of 2 to 3. The average dividend paid by the Union Co. during the past nine years has been 8·89 per cent. and that of the A.E.G. 12·56 per cent. in the same period. The agreement, which will come into operation next July, is for a period of 35 years. It is understood that each company will devote special attention to those branches in which it is the strongest, and the company which is most advantageously situated for the production of any particular manufactures will continue their output, whilst the other, which is less favourably circumstanced for the same classes of goods, will abandon operations in these directions.

The transaction between the two Berlin companies has been sympathetically and favourably received in German stock exchange circles not only on account of the establishment of such a friendly connection between the enterprises, but also because it is believed the agreement will result in the realisation of considerable economies in working which are deemed to be specially necessary in the preparation of schemes for works thrown open to competition. As before mentioned, the A.E.G. has hitherto paid $1\frac{1}{2}$ per cent. in dividends for every 1 per cent. distributed by the Union Co., and it is therefore considered that, having regard to the difference between the share capitals, the proportion of the net profits allocated to each is mutually advantageous to the companies. It is as yet too early to form any opinion as to the probable effects of the community of interests which has now been practically established on the present scale, but further developments may be expected to take place shortly. The Siemens & Halske Co., it is understood, is not indisposed to enter into a price convention, whilst the Schuckert Co. would not refrain from participating in any such agreement in the event of its being proposed. However that may be, it is apparent that the A.E.G. will not rest content with its present success, but will continue to endeavour to bring other companies either within the pool or in some other form of working agreement; and whatever may be the effects in Germany, it is obvious that the movement which has been started will tend to enhance the competitive capabilities of the Teutonic companies in external markets, and it is therefore all the more necessary for British firms to prepare to meet the more severe rivalry which is bound to come in the near future.

The Taff Vale Case.

The Trades Unions have experienced another defeat in a Court of Law. The case of the Taff Vale Railway Co. *v.* The Amalgamated Society of Railway Servants, which occupied the attention of a judge and special jury for nearly a fortnight, terminated in favour of the railway company, who sought to recover damages occasioned by the strike of their employés in August, 1900. The action was brought against two of the secretaries and three members of the executive committee of one of the most powerful unions in the country. It was alleged that they had instigated and conducted the strike, in the course of which violence and intimidation was used towards the company's servants, and as a result of which the company sustained heavy losses owing to their inability to fulfil numerous contracts, and to the disorganisation of traffic. At the conclusion of the case, which was fought regardless of expense, Mr. Justice Wills left the following questions to the jury :—(1) Did the defendants conspire together to molest and injure the plaintiffs by unlawful means? (2) Did they or any and which of them unlawfully persuade the men whose notices had not expired to break their contracts? (3) Did they or any and which of them authorise and assist in carrying out the strike by unlawful means? That the jury felt little doubt about their verdict is evident from the fact that after a few minutes' deliberation in the box they answered all three questions in the affirmative. Judgment was not entered at once, for the defendant union has to put forward the further contention that the officers were acting *ultra vires* when they set the strike on foot; but it is easy to see that the jury felt no doubt as to the complicity of their officials. Having regard to the overwhelming evidence which came to light to the effect that the strike on the Taff Vale Railway was authorised by the Amalgamated Society, we are at a loss to understand why this case was ever taken to court. Having reached the King's Bench, it will probably go to the House of Lords; and bearing in mind the fact that it has already been before that august tribunal on a preliminary point—namely, whether a union can be sued in a corporate capacity—the costs of the entire litigation will be something fabulous. We do not fear for the result of an appeal. It will be a sad day for English justice when the responsibility for acts of violence and intimidation committed, it is true, by strikers themselves cannot be brought home to those whose superior ability has placed them in a position to order and direct the progress of a strike. The pity of it is that the bill is to be sent in to the the Union, and not to the agitators who make their living by stirring up strife between employers and employed; though, indeed, it were an empty mockery to send in a bill to persons who, in time of prosperity, are supported by the union, but who, when the creditor is at the door, can show a pair of empty pockets.

It may be a coincidence, but it is undoubtedly the fact that since the common law of England has been declared sufficiently powerful to prevent a strike from being conducted in an illegal manner, strikes, and the many breaches of law and order attendant upon them, have diminished in number. When a trade or business is disorganised even for a day or two, the injury to employers mounts up to something considerable. Hitherto there has never been any necessity to inquire into the amount of this loss, inasmuch as the sufferers have been unable to seek redress; but this state of things is altered by recent cases. Every additional hour during which the strike lasts may now mean a call upon the union funds far exceeding the necessary strike pay and the other costs entailed by a strike. We expect that members of trade unions will soon cease to put their faith in the agitator who leads them headlong into a costly battle with employers who are determined to vindicate their rights.

Disturbances on Underground Cables.

Mr. W. Schönau, in a short article contributed to a contemporary, gives an interesting account of certain disturbances which were found to exist on three telegraph cable circuits terminating at Shanghai, there being intermediate between Woosung (the submarine cable termination) and Shanghai, a length of 9 miles of underground lead-sheathed cable. The latter cable, it appears, consisted of seven cores, six of which were utilised for the circuits—viz., two for each—the circuits in each case being from the submarine cable conductor, through one of the lead-sheathed cable cores to Shanghai, and thence back through a second core to the submarine cable sheathing. Considering that the underground cable was, apparently, of the ordinary type, it is not at all surprising that disturbances from circuit to circuit took place. It is well known amongst telephone experts that electrical symmetry cannot be obtained unless twisted pairs, with each pair of a different "lay," are used. The addition of an earthed condenser and resistance to one of the wires of the untwisted loop will often produce electrical symmetry. We say "often," for as regards telephone working it may be mentioned that although such symmetry may be obtained as will cause a sensitive galvanometer placed in one loop to be absolutely unaffected by a very powerful current sent through one of the other loops in the cable, yet this symmetry will not be sufficient to prevent overhearing between the two loops when used telephonically. In fact, it has been found that an ordinary "electrical" or "bridge" balance is not necessarily a telephonic balance, and *vice versâ*—*i.e.*, when telephonic silence was obtained between two loops, yet a galvanometer on one loop would be affected by a current in the other loop. The contention of our contemporary that the disturbances were mainly due to leakage currents from one cable sheathing to another, and not to induction, because "presumably the seven cores of the cable are symmetrically disposed in the leaden tube," is quite incorrect, for, as before stated, paired conductors in a seven-core cable of the ordinary make cannot possibly be neutral, either theoretically or practically, to each other; also leakage currents would not, it is believed, be neutralised by a condenser in the manner shown.

Thermo-Electric Power and Magnetisation.

Several investigators have shown that the thermo-electric power of a couple containing a magnetic metal is changed when the junction is acted on by a magnetic field. This change may be due either to the stresses of Maxwell's theory or to the molecular movements which produce changes of length in an iron bar when it is magnetised. It has been shown that the changes of length are not due to the Maxwell stresses, whose tendency is to reduce the amount of the change, but rather to something in the nature of an orientation of the particles of the magnetic metals. The actual change observed is that due to the difference of these two opposing forces. By eliminating the effect of the Maxwell stress the change of length due to orientation of particles can be determined. It has been found that when a gradually increasing magnetic field is applied to a bar of iron, its length rapidly rises to a maximum and then slowly decreases. If a cyclic change takes place in the magnetic field, a cyclic change results in the length of the bar of iron, the ascending and descending curves being non-coincident, as in the case of hysteresis. Mr. Edward Rhoads (*Phy. Rev.*, Dec., 1902), has shown that when a cyclic magnetic field is applied the cyclic changes of the thermo-electric power of a couple containing a magnetic metal correspond very closely with the cyclic changes of length due to the orientation of the particles of the magnetic metal. It would appear from these experiments that the orientation of the particles is the true cause of the change of thermo-electric power of magnetic metals, and not the Maxwell stresses, a conclusion which must be of considerable value in molecular physics.

OBSERVATIONS ON THE OHMIC RESISTANCE OF ELECTROLYTES, AND ITS DETERMINATION.

By J. WRIGHT.

The above is a problem which is, even yet, far from a satisfactory solution, owing to the several reactions which occur in and at the electrode surface of an electrolyte during the passage of a current through it.

Not the least of these reactions is that known as polarisation, involving the presence of a layer of air-bubbles, ions, &c., between the liquid and its terminal electrode. It has also been clearly demonstrated that an alteration in the resistance of the liquid takes place near the electrodes, and is due to a radical change in the condition of the electrolyte forming a small portion of the liquid column, the resistance of which it is required to measure. Last, but not least, there is the back E.M.F., or electromotive force of polarisation, which is set up in opposition to the E.M.F. of the testing current.

Let E be the difference of potential between two electrodes immersed in an electrolyte, C the current through the latter, R the supposed resistance of the liquid column between the electrodes, and E_1 the electromotive force of polarisation; then $R = \frac{E - E_1}{C}$, and it is obvious that to determine R it is necessary to know the value of E_1, thus illustrating the difficulties to be contended with in the determination referred to in the title of this article.

The E.M.F. of polarisation leads to a difference of potential at each single electrode, converting the latter, in point of fact, into a two-plate condenser, the capacity of which is considerable, and has been called the polarisation capacity of the electrode.

Transitional resistance, caused by the presence of air-bubbles at the surface of the electrodes, may be eliminated by physical means, such as boiling the electrolyte with the electrodes in position. Very little polarisation trouble is met with in cases where the electrolyte whose resistance is to be measured is a metallic salt, and the electrodes consist of the metal itself; thus the resistance of sulphate of copper or zinc solutions is approximately determinable by the ordinary Wheatstone bridge methods of resistance measurement, if copper or zinc electrodes amalgamated with mercury be respectively employed for the purpose. Such measurements have, indeed, been successfully conducted by several scientists, amongst whom may be mentioned Paalzow and Beetz.

Another method adopted by the former of these gentlemen consisted in placing the liquid, the resistance of which it was required to measure, in a carefully calibrated tube, ending in cylinders of porous clay, which latter were themselves immersed, together with amalgamated zinc electrodes, in wide vessels containing a solution of sulphate of zinc. The electrode contact was thus made, not directly with the solution under test, but through a secondary fluid; the polarisation at the meeting point of the dissimilar fluids being extremely slight, was, together with the resistance of the porous clay extremities, eliminated by taking a series of observations with tubes of varying length.

Wheatstone and others adopted a rather novel but crude method for the determination of the resistance of electrolytes. Two electrodes were immersed in the fluid and a certain current was passed through. The distance between the electrodes was then decreased, and the current brought down to its original value by inserting resistance into the circuit, the value of the added resistance being taken as a measure of the unknown resistance of the fluid. As before observed, this method is inaccurate, as an equal condition for the electrodes cannot be guaranteed in both cases.

Ewing and MacGregor's method consisted in enclosing the electrolyte in a tube with enlarged ends, in which were inserted the electrodes. The whole arrangement was connected as one arm of a Wheatstone bridge system, the two fixed arms being made of high resistance, and a highly sensitive galvanometer was employed to obtain a balance, such that very small momentary currents only were passed through the liquid.

One of the most common methods, however, which has been adopted by many experimenters, consists in enclosing the electrolyte in a tube, and immersing two platinum electrodes therein at a definite distance apart. A uniform current is then passed through the fluid column, and the difference of potential between the two electrodes compared with that between two points on a standard and homogeneous slide wire, included in the circuit and carrying the same current. The capacity of the electrometer, if such be used for the test, must be small compared with the polarisation capacity of the electrodes, or a sensitive, high-resistance, reflecting galvanometer in conjunction with small currents, may be used for the purpose. The effects due to a possible polarisation E.M.F. are eliminated by taking readings for two different directions of the current.

Bouty's method, which resembles that of Paalzow, is an attempt to eliminate the polarisation trouble by adopting liquid terminals consisting of a metal, zinc, immersed in a solution of its own salt, zinc sulphate. The apparatus consists of an insulating tube, T, fig. 1, coiled into a double spiral as shown, to render it non-inductive, and terminating in two enlarged ends or cups, *a*, *b*, into which dip one limb each of the two siphons, S, S_2. The remaining limbs of the siphons are immersed in the liquid in two porous vessels, P, P_2, which are themselves placed in solutions of sulphate of zinc, W, contained in troughs. In each of the latter is also placed an amalgamated zinc plate, Zn, which provides the means for terminal connection to exterior apparatus. The spiral tube, T, is bodily submerged in a bath, B, preferably of oil, which, during the test, is maintained as nearly as possible at a constant temperature. The tube, cups, siphons, and porous vessels are filled with the electrolyte whose resistance it is required to measure, and the cross-sectional area of the cups, siphons and porous jars, compared with that of the spiral tube proper, is such as to render negligible the resistance of the column of liquid contained therein, it being only 0·001 of the resistance of the actual spiral column which it is required to ascertain. The potentiometer method is adopted for the test, a Lippmann electrometer being employed for the purpose. The terminals of the latter are connected to the two zinc plate electrodes, and the resulting displacement restored to zero by an adjustable derived circuit, consisting of a resistance box, over which there is a suitable fall of potential created by a battery connected across its terminals. The arrangement thus resolves itself into a species of potentiometer.

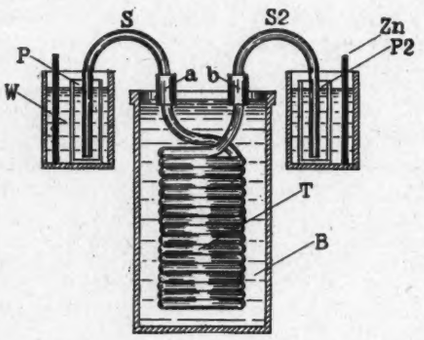


Fig. 1.

An even more direct application of the potentiometer principle to this measurement in practice has lately been successfully instituted by Carl Hering, and was described by him in a paper read before the American Institute of Electrical Engineers. The apparatus employed for the purpose consists of a rectangular tank, built of insulating material, such as waterproofed wood or ebonite, and very carefully constructed as to homogeneousness of dimensions, in order that the column of liquid contained therein may be of uniform cross-sectional area. A suitable scale is provided along the upper edge of the tank, T, fig. 2, and two compartments, A and B, one at either end, are partitioned off from the remainder of the tank by porous walls. These two compartments serve to contain the main terminal electrodes, *c* and *d*, the object of the porous partitions being to prevent the products of decomposition from altering the nature of the electrolyte under test. Since the latter only involves the actual column of liquid bounded by the two

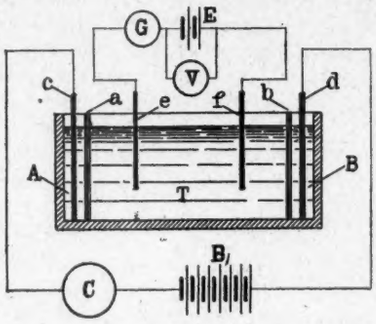


Fig. 2.

porous walls, *a* and *b*, the electrical resistance offered by the latter, and the fall of potential at the main electrodes, are immaterial, and may, in point of fact, be comparatively high, without interfering with the test. A suitable direct current is passed through the liquid in the tank, from the secondary battery, B; it must be of known value, and be maintained constant during the test; to this end the ammeter, C, is introduced into the circuit. To ascertain correctly the difference of potential between any two given points in the liquid column, it is obvious that, at the moment of measuring, there must be absolutely no change in the current flowing in that particular section of the column, as otherwise a large and variable error would be introduced into the results. With a view to annulling any current variation, the two auxiliary electrodes, *e* and *f*, which are adjustable as regards their parallel distance apart, are connected with another direct source of electromotive force, E, the latter being so arranged as to oppose the current in the main circuit. A galvanometer, or current indicator, G, is also included in the auxiliary circuit, whilst a voltmeter, V, is connected across the terminals of the battery, E.

All details being arranged as described above, the auxiliary electrodes, *e* and *f*, are moved further apart or nearer together, as occasion demands, until the indication on the galvanometer, G, is zero, showing that no current is passing. Then, given the current in the main circuit, the E.M.F. of the battery, E, at the moment of balance, and the length and cross-sectional dimensions of the column of liquid between the auxiliary electrodes, *e* and *f*, it is possible, by Ohm's law, to deduce the actual, or specific, resistance of the liquid under test. Mr. Hering employed gold as the most suitable material for the electrodes, and, though only utilising this method for a practical purpose, where great accuracy was not an essential, he found the figures obtained by its means compared very favourably with those which have been published from time to time by other experimenters.

Drs. W. Stroud and J. B. Henderson employ a direct-current Wheatstone bridge method of resistance measurement, and overcome the polarisation difficulty by adopting what they term a *balancing cell*, *i.e.*, an electrolytic cell, having the same cross-sectional area and electrode dimensions as the main cell, which contains the electrolyte to be tested, but embracing a much shorter column of liquid between its extremities. The form of cell adopted by these gentlemen for their experiments is very simple and convenient. It consists of a rectangular trough, T, fig. 3, containing paraffin oil, which is maintained as nearly as possible at an even temperature during the tests. Immersed in the oil is a heavy rectangular block of wood, W, fitted at its centre with a vertical handle, by means of which it can be gently raised and lowered in the oil, thus agitating the latter, and assisting in maintaining a uniform temperature. Mounted vertically in this block are four test tubes, *a*, *b*, *c* and *d*, of thick glass, arranged at definite distances apart, and forming the termini of the two electrolytic cells, being paired off, *a b* and *c d*. The tubes are about 6 cm. high, and 1·25 cm. in diameter, and are provided with horizontal outlets, as shown, at a point half-way up one side. Into these openings are carefully fitted the

well-ground extremities of two horizontal tubes, A, A_2, of uniform bore, but varying length, that of A being some 30 cm., and of A_2 only 5 or 6 cm. We thus have two glass structures

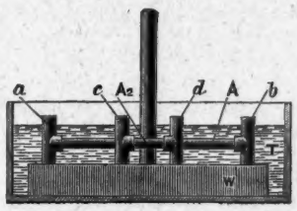


Fig. 3.

of H formation, terminal connection with the vertical limbs of which is obtained by equal cylinders of platinum foil, made of such a size as to fit inside the tubes, *a*, *b*, *c* and *d*. To each cylinder is welded a short length of platinum wire, which is bent over, and dips into one limb each of four U-tubes (not shown in the figure) containing mercury. Extraneous apparatus is connected with the cells by wires dipping into the remaining limbs of the mercury tubes. The arrangement of the cells and other apparatus for the test is represented in the accompanying diagram, fig. 4, in

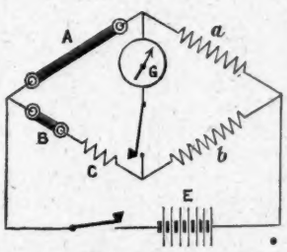


Fig. 4.

which A, B represent the main and balancing cells respectively; G, a d'Arsonval galvanometer; *a* and *b*, equal resistances of about 2,000 ohms; E, a source of direct current; and *c*, the adjustable resistance, whereby balance is obtained. It will readily be seen that, given a complete balance, and consequently equal currents in A and B, the respective polarisations should be equal and opposite; with a testing voltage of from 30 to 40, it has been found possible to obtain an accuracy of 99 per cent. at the very least, with this arrangement.

Suitable constants can, of course, be readily obtained for the two tubes, A, A_2, fig. 3; for instance, by filling them with mercury, and subsequently weighing the quantity required in each case.

The system of measurement devised by Kohlrausch is, perhaps, the best known and most widely recognised method of electrolyte resistance measurement, but is a somewhat inconvenient test to apply in that it involves the use of a special bridge. The latter comprises a stretched wire some 24 c.m. in length and a slider, a set of non-inductive resistance coils, having values of 0·1, 1, 10, 100 and 1,000 ohms respectively, an induction coil and contact breaker for producing an alternating current, and a lever switch for controlling the connections according as a galvanometer or a telephone is used.

The method is that of the Wheatstone bridge pure and simple, an alternating current and a telephone receiver being substituted for the battery and galvanometer usually employed in such tests. A general plan of the connections when the main and balancing cells described in connection with the Stroud-Henderson method are adopted for the test, is represented by fig. 5, in which A and B represent the cells as before; *a*, *b*, the two remaining arms of the bridge; *c*, the adjustable arm, or portion of the slide wire; C the induction coil; and T the telephone receiver.

The efficacy of this test is based upon the assumption that alternating currents do not produce electrolytic changes, but that they can, and do, produce such effects at all frequencies within the range of ordinary practice has been evident for some time, and a very simple experiment will serve to demonstrate this fact. If the extremities of a circuit carrying an alternating current of ordinary frequency be applied to a piece of pole-finding paper in the usual manner, a distinct marking results at one of the poles, thus illustrating that electrolytic action has taken place.

Mr. Duddell has already investigated this point, and in a paper communicated by him to the Royal Society last year on "The Resistance and Electromotive Forces of the Electric

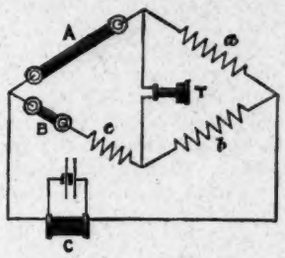


Fig. 5.

Arc," he describes his experiences in measuring the electrolytic resistance of a sulphuric acid cell of density 1·20, at a temperature of 20° C. It was not until a frequency of over 10,000 periods per second was reached that the cell behaved as an ordinary non-inductive resistance, and polarisation errors were eliminated.

The secohmmeter has been called in as an aid to the measurement of electrolytic resistance, the bridge method being adopted, and the commutators of the secohmmeter so adjusted that a reversal of the galvanometer connection is secured alternately with two consecutive reversals of the battery current. It is, however, open to the same objection as the Kohlrausch method, in that, with the speed normally attained, the reversals of the testing current are not sufficiently frequent to prevent polarisation errors from creeping in.

Summing up these various systems, it would appear that the greatest merit and possibility of accuracy belong to that devised by Mr. Hering, though the alternating current method, with high frequencies, suggests a field for further investigation.

LIQUID FUEL FOR ELECTRICAL STATIONS.

By W. H. BOOTH.

Just at present the question of liquid fuel is very much in evidence, and to the layman it presents itself in a manner somewhat convincing. There is, however, a very considerable lack of the sense of proportion in many who discuss the question of liquid fuel without a sufficiently full knowledge of facts.

In Great Britain alone over 200 million tons of coal are raised each year. In the United States the amount is still greater. The present production of mineral oil is a mere fraction of the 773 millions of tons of coal produced in the world. Glowing accounts appear from time to time of the appearance or discovery of gushers which spout many millions of gallons of oil before they can be brought under control. It is as though the waste of this oil were absolutely necessary. All who bore for petroleum hope to find a gusher; one would imagine that with a prospect of doing so, the upper end of the bore pipe would be provided with a stop valve of ample size to pass the boring tools, and with a ready fixed handle of sufficient length to close the sluice from a distance, so as to prevent needless waste. These tales of gushing wells seem to point to as foolish a procedure as the original Chinese method of preparing roast pig by burning down a house. There exists, also, among those who have oil to sell, a habit of raising prices as soon as a demand has been created. Such an instance recently occurred where a prospective oil user, who had based his

calculations upon a price of 32s. per ton, found that he was expected to pay 65s.

Similarly, when Holden's system was applied to some South American locomotives, the price of oil was raised as soon as all the engines were known to be fitted. In that instance the sellers reckoned without their host, and in ignorance of the mechanical details of the system, and felt much aggrieved when the engines all ran out on coal alone.

Liquid fuel has undoubted advantages in many cases, and probably nowhere could it be used to better advantage than in an electric light station.

One of the principal advantages of oil is its high calorific value per pound. This, with the best oils, is double the capacity of the inferior coals, and 30 per cent. better than the best coal. The ease with which it can be stored and moved from point to point is an advantage. It can be fired mechanically, makes no ash or clinker, can be burned at maximum rate, or entirely shut off in a moment. Further, a very large power of boilers requires very little labour in the stokehold.

Petroleum consists of a very large variety of constituents; these are gaseous, liquid or solid. The gas is marsh gas, CH_4, and at once disappears; the lighter liquids are very volatile, and finally, there are solid bodies at the end of a long series of liquids of varying degrees of volatility and specific gravity.

The chemical formulæ which cover all the constituents of petroleum are $C_n H_{2n}$ and $C_n H_{2n+2}$. These formulæ continue throughout the whole range from marsh gas CH_4 onwards.

The Texas oil is used chiefly as it is found.

The Russian oil is used in the form of astalki or residuum, the proportion left after distilling off the lighting and lubricating oils. Much of the American oil is also used in the form of residuum.

The proportion of carbon in all the liquids used as fuel varies very little from 84 per cent., the hydrogen amounting to 16 per cent. There is little else, so that petroleum is practically all combustible.

It may be laid down as a well-established rule that there is at present only one way to burn liquid fuels for steam raising, and that is by atomising the fuel in company with a sufficient amount of air around each atom. In order that the oil may atomise freely, it should be deprived of its viscidity. This is readily done by heat, and brings with it the further advantage that any water in the oil more easily separates out of hot oil than out of cold oil, first, because the heated oil being more limpid, offers less resistance to the freeing of the water; and, secondly, there is greater expansion of oil than of water due to heat, and the water gains a relatively greater specific gravity.

Warming is done by means of a steam coil, and it may be merely local warming in the vicinity of the take-off valve in the tank. It is essential that water be fairly well separated, because if it comes through the burners in any quantity it may extinguish the fires, and the next following oil is apt to ignite very explosively.

In storing oil there is always apt to be some vapour given off, and an empty tank ought not to be entered with a light.

Though not nominally of double the calorific capacity of average fair coal, oil is found in practice to be worth double the price of coal, owing to the labour-cost which it saves. This is as regards marine service, for the oil can be carried in ballast tanks, and paying cargo is carried in the coal bunker space.

For land purposes, of course, these latter considerations do not weigh, and the relative value must be based on the performance ratio of about 16 to 10, together with the economy of labour, cleaning, ash cartage, &c.

Above and beyond all these things, however, is the power which liquid fuel gives of immensely increasing the steam production of a boiler at short notice.

In general practice a steam boiler is designed with a given ratio of heating surface per unit of fuel burned. Any reduction of this ratio is accompanied by a poorer performance. Less steam is produced per pound of fuel consumed. A reduction of the heating surface ratio does not, however, reduce the performance in anything like the same ratio. If a large demand for steam is made upon a boiler for a short fraction of its working hours, it may be cheaper to consume fuel at a high rate for a fraction of the time than to employ two or even three boilers at normal rates during a fraction of a day, the extra boilers remaining idle during the rest of the day, albeit when the heavy load is past these extra boilers are retired hot and full of energy. The saving by the first method is very considerable in respect of space occupied, buildings and capital cost generally, and if not carried too far it will outweigh the fuel cost of the short run at heavy output.

For this system of working, coal can, of course, be employed. Coal, however, cannot be fired at abnormal rates with special ease. A mechanical stoker does not readily increase its rate of working. The better forms of stoker—on the coking principle—find it very difficult to put their whole grate surface into the new and forced condition. The sprinkler class again do not work so well at abnormal rates. Coal combustion is only to be regulated by draught intensity. With oil the rate of supply is instantly variable to suit the steam required, and a boiler can be rapidly put under its fullest output rate of work. With boilers of the small tube type especially, their small water contents enables the engineer to leave them standing cold to within a short time of maximum output. Oil is then turned on, and in a few minutes the boiler is in full work. When a boiler is already at work the mere turn of a handle puts it into its maximum steam-producing condition.

As soon as the demand ceases the oil can be turned off and the normal coal fire continued or the boiler laid off entirely. By means of liquid fuel great elasticity is possible.

In a lighting station the load factor is very usually about 12 per cent. That is to say, about one-eighth of the plant is, on the average, at work all the working hours.

This excessive misproportion is remedied to any desired extent by means of accumulators, but it is not yet commercially economical to instal so high a proportion of battery power as to enable the power plant to run at steady load all day. The peak of the load, however short in duration, cannot be surmounted without the aid of power, and it is to the height and small duration of the maximum load curve that the poor load factor of a lighting station is due. Accumulators for heavy output of short duration greatly improve the load factor, but in any case the number of boilers at work to tide over the peak is several times the mean number.

If by means of liquid fuel, boilers can be heavily pushed for two, three, or four hours, the capital outlay on boilers will be much reduced. When the various points are taken into account, the boiler scheme that will probably suggest itself will be, first, some boilers of Lancashire type, economical and steady steamers; secondly, large tube water-tube boilers with a moderate water contents and large grate area, and with efficient steam driers or superheaters. These boilers can be heavily forced with some sacrifice of economy, but the priming due to heavy forcing must be eliminated by a good superheater. This is essential to economy. Thirdly, small tube boilers of very small water capacity, capable of being heavily forced, delivering their steam preferably above water level in the steam drum. If all these boilers are fitted with oil sprayers, the maximum demand for steam will be met with the minimum of capital outlay.

It is a common fallacy to suppose that boilers of small water capacity respond most readily to a sudden demand for steam. The claim is, it is true, often made for water-tube boilers. Nothing could be more erroneous.

When a boiler is at work under full pressure, the whole of its water is at the temperature which corresponds with the pressure. Any addition to the furnace activity cannot add to the heat contents of the boiler, unless the pressure is allowed to rise; obviously, therefore, given the continuance of the same pressure, the boiler of large water contents will answer to an urged fire, just as rapidly as a boiler of no water contents. When boilers are standing at rest, however, and cold, the boiler which contains least water will, *ceteris paribus*, become most quickly hot. Such a boiler, as for example the Solignac, which holds almost no water, can be made by aid of oil fuel to produce its maximum power in a few minutes after lighting up.

In this respect oil has a very decided advantage over solid fuel. To secure a good fire with solid fuel there must be a thick bed of incandescent fuel on the grate, and this can only be built up with comparative slowness, and when its duty is over it remains a more or less wasted force. With oil, however, the maximum fire is instantaneous, and the only drawback is the cold brickwork of the setting which must become hot before the maximum furnace duty is attained.

For ordinary economical work the number of heat units that a boiler can absorb per square foot of heating surface will not be changed when liquid fuel is employed, except so far as liquid fuel can possibly be burned without smoke more easily than solid hydrocarbons such as coal, and that therefore the heating surface is maintained clean and free from dust and soot, and therefore more efficient. But mere evaporative efficiency must not be allowed to overweigh the overall, or commercial, efficiency. Exactly what governs the relation between evaporative and commercial efficiency cannot be stated positively. Indeed, commercial efficiency alone should be considered as the true basis of design. It may, however, be stated in general terms that plant which is on duty for long hours may probably be designed to work more economically as regards fuel than plant intended to work very short hours.

Let it be assumed that the boilers which are economical of fuel have an efficiency of 72 per cent., and that the small highly pushed boilers are run at 60 per cent. efficiency for three hours.

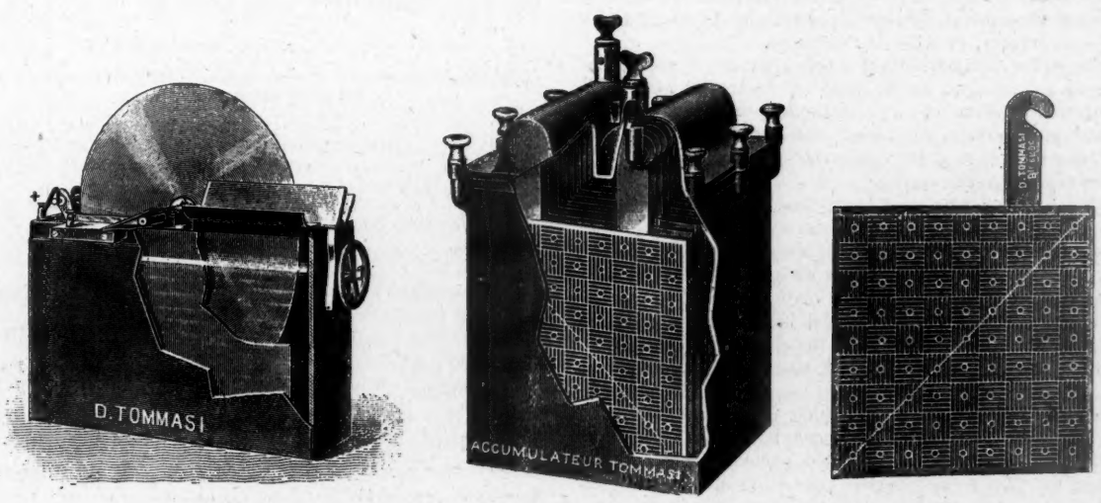
Then, in course of a year, coal is wasted which represents 12 per cent. difference of efficiency lost for three hours daily.

To enable this loss to be avoided, there would be so many thousands of pounds extra capital cost in boilers, buildings, &c., and where oil is not employed, so much more labour cost as compared with oil. Properly equated at a suitable rate of interest and depreciation, the relative value of the alternative systems may be found after the manner of the Kelvin law applied to cable work. In many stations the extra labour for the heavy duty period must be difficult to arrange satisfactorily. Men are probably employed more hours than they really work, and where it may pay best to use coal for 10 hours, the labour cost may make it cheaper to use oil for 4 hours of a peak load even if, in mere fuel cost per unit, the oil is more expensive. Recent trials with liquid fuel show that there is still much to be done in reducing the air supply. The air required to burn 1 unit weight of carbon is 11½ units. An ordinary oil fuel requires fully 15 units with, of course, the additional excess as with solid fuel. But with oil fuel there ought to be better mixture of air and fuel, and therefore better combustion with less excess of air.

If we regard air as the fuel and coal or oil as the sustainer of combustion, as we have a chemical right to do, we shall arrive at the conclusion that approximately the calorific value of a fuel in actual duty done will not differ much from the chemical ratio of air required in the combustion process. The large amount of air per pound of oil arises from its large percentage of hydrogen, and it is the large capacity for oxygen possessed by hydrogen which renders the theoretical temperature of combustion so nearly alike that of carbon, in spite of hydrogen's high calorific capacity.

As regards the production of petroleum, that of the United States in the year 1901 was 69,389,194 barrels, valued at 66½ million dollars. If each barrel is assumed to contain 360 lbs., or, say, six barrels per ton, the total tonnage will be 11,565,000, and the value, therefore, something under 23s. per ton, or practically $1 per barrel. Thus the weight of the oil produced in the United States is about 5 per cent. of the weight of coal, or, say, 7½ per cent. of the calorific capacity. After the removal of lighting and lubricating oils, the amount of fuel oil remaining will be quite small as compared with the coal output. In the absence of figures of the Russian and other yields of oil, it may be assumed that the total oil production of the world is less than 5 per cent. of its coal production. Any idea of entirely displacing coal must be out of the question, unless the yield of oil be increased beyond any present prospect, and the use of fuel oil must therefore be undertaken with common sense caution, and not in any wholesale manner, to the expected exclusion of coal.

At the same time, when the limitations of the subject are recognised, it cannot be denied that liquid fuel lends itself to certain conditions as to steam raising which must render it extremely valuable and of great convenience. Marine work and electrical work are, par excellence, the two lines along which liquid fuel appears likely to advance most successfully.



Dr. Tommasi's New Electrolyser and Accumulator.

A NEW ELECTRIC ACCUMULATOR.

By DR. D. TOMMASI.

The plates of this accumulator consist of a leaden frame containing a very large number of layers, also of lead, placed very close together so as to retain the active material and convey the current into every part of it. These layers are arranged in groups of seven, placed alternately vertically and horizontally. By this arrangement the expansion of the plate occurs in both directions at once, and consequently it is much less appreciable.

Each plate is divided into 81 compartments 15 mm. square, each containing, as has been said, seven layers.

The layer in the centre of each compartment is fitted with

a little leaden ring in order to allow of the passage of the electrolyte and its diffusion through the active material. The plate is provided on both surfaces with a diagonal sheet of lead, which enables the current to pass directly into all the empty spaces in the plate, and which is kept in its place by the different layers crossing these empty spaces.

The active material obstructing the little rings placed in the middle of each compartment is removed, so that the electrolyte can easily come into contact with every part of the active material. This arrangement thus avoids the formation of concentration currents, by virtue of the perfect diffusion of the electrolyte throughout the mass of active material.

The constants of this accumulator (Model T 5) may be summed up as follows :—

Number of plates	5
„ „ positives	2
Length of the plates in millimetres	140
Breadth „ „ „ „	140
Thickness	3
Duration of the discharge in hours...	5
Mean difference of potential in volts	1·9
Output in amperes	6
Capacity in ampere-hours	28
Power in watts	11·4
Energy in watt-hours	54·15
Output in amperes per kg. of effective plates* ...	3·8
Capacity in ampere-hours per kg. of plates ...	17·75
Power in watts per kg. of plates	7·1
Energy in watt-hours per kg. of plates	33·7

* Two positive and two negative.

At the rate of 1 ampere per kg. of plates there is a working capacity of 36 to 38 ampere-hours, or 22 to 24 available ampere-hours per kg. of plates.

The writer has devised an electrolyser for the preparation of spongy lead to be used in accumulators. This apparatus consists of a rectangular trough containing a solution of double acetate of lead and sodium, with the addition of certain compounds, the object of which is to lessen the electrolytic resistance of the bath and to prevent the formation of peroxide of lead. In this bath are immersed two anodes of lead; between these anodes is placed the cathode, which consists of a metal disc to which can be imparted a rotary movement. The disc is not entirely submerged in the bath, but merely one segment of it, so that each part of the zone to be wetted is alternately in the air and in the liquid which serves as the electrolyte. That part of the disc that is entirely out of the solution passes in the course of its rotary movement between two rubbers in the form of scrapers, the object of which is not only to remove the spongy lead * as it is produced, but also to depolarise the surface of the disc. Channels made for the purpose receive the metal detached from the disc and convey it into a receiver.

The electrolytic lead presents the appearance of a spongy mass, consisting of a number of little crystals which are very light and very plastic. The lead in this state constitutes an excellent active material for accumulators of any type, and particularly for the Tommasi accumulator described above. In fact, the great plasticity of this lead renders its application to the electrodes of accumulators an easy matter, and its extremely divided state renders it eminently suitable for being transformed rapidly into peroxide of lead under the influence of the electric current.

REDUCING THE MEASURED DR OF A LAID SUBMARINE CABLE TO 75° F. AND ATMOSPHERIC PRESSURE.

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That the measured DR, multiplied by the length, and reduced to 75° from the *mean* temperature (whether calculated from the CR or observed by temperature soundings) and corrected also for the *mean* pressure, will not give the true DR per N.M. at 75°, and at atmospheric pressure, is, no doubt, known to most experienced cable electricians; but there are many who are unaware of the fact, and more still of the method of arriving at the correct value from the measured DR.

That it is not more generally understood is due to the remarkable fact that none of the best known text-books on electrical testing deal fully with the solution of this problem.

In their excellent work on "Submarine Cable Testing," p. 96, Messrs. Fisher and Darby do indeed point out that to correct the measured DR of a laid cable to 75° by the coefficient for the mean temperature, does not give even an approximately correct result, but no formula is given from which to obtain the true value. In the equally practical and valuable text-book, entitled "Electrical Testing," Mr. Elton Young not only refers to this subject, but sets forth a formula for correcting the DR for different temperatures. It is practically the same as that given by Mr. H. R. Kempe, in his "Handbook of Electrical Testing," which has justly won for him a world-wide reputation among electricians, and to which I shall refer later on.

The question is one of great importance, as will be evident by first considering the following example of a cable, having a uniform DR and CR throughout its length at 75° F., and equally coiled in two tanks of water having widely different temperatures, but where no correction for pressure is required :—

Parts.	Length. N.M.	DR (Megs.) Total.	DR (Megs.) Reciprocal.	DR (Megs.) Per N.M.	CR (ohms.) Total.	CR (ohms.) Per N.M.	Temperature.	DR. Coefficient.
...	200	5·	...	1,000	2,400	12·00	75°	1·0000
The same cable when $a + b$ are at widely different temperatures but at the same pressure;								
a	100	10·	0·10000	1,000	1,200	12·00	75°	1·0000
b	100	143·14	0·00699	14,314·	1,109·	11·09	40°	14·3140
	200	9 347	0 10699	...	2,309·	11·545	57·5°	...
The mean temperature calculated from the CR and the DR coefficient, are							57 55°	3·769
which latter gives for the whole cable								
$a+b$	200	2·480	...	496 Ω	...	...	...	...

This apparently low DR per N.M. (496·0 Ω), as reduced from the mean temperature, would reasonably make anyone ignorant of the real cause imagine that the cable insulation had fallen; whereas it entirely arises from such a reduction to 75° being incorrect. From the above example it will be evident that dividing the measured DR (9·347Ω) by the coefficient (3·769) for the mean temperature gives a very much lower result (2·480Ω) than separately dividing the DR of b (143·14Ω) at its sea temperature (40° F.) by its corresponding DR coefficient (14·314), which gives a value of 10 Ω, and then calculating the true DR of this section at 75° in circuit with the additional 100 N.M. which has been tested at 75°, and therefore should have no coefficient applied to it. The difference—as shown in the table—is that between 496 Ω and 1,000 Ω per N.M.

Next consider the case of a cable laid in varying depths where the bottom temperatures consequently differ, and where a correction has also to be made for the effect of pressure in increasing the DR.

Suppose the cable to be divided into several parts, as in fig. 1, each of a length depending on the occurrence of a marked change of depth in which it is laid.

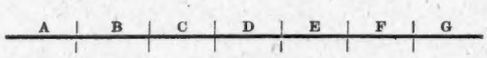


Fig. 1.

The bottom temperatures for these depths are best obtained from a curve plotted from *temperature soundings* at various depths along the route, so as to give a tolerably approximate bottom temperature for intermediate depths where no temperatures have been taken.

The coefficients for pressure are obtained from the following formula :—

Depth in fathoms × 2·676 × 0·00023,

the increase in the DR per megohm being 0·00023 for every

* When the lead contains silver, this metal, being insoluble in the bath, is deposited on the bottom of the trough in a perforated receiver placed there to collect it.

pound pressure, and the weight of sea water per fathom, 2·676 lbs.

Let A_t, B_t, C_t, &c., be the respective observed temperatures of these parts.
A_p, B_p, C_p, &c., be the respective sea pressures of these parts.
A_k, B_k, C_k, &c., be the respective lengths in N.M. of these parts.
A_r, B_r, C_r, &c., be the respective ratios obtained by dividing the mean DR per N.M. at 75° F. (as *core*) for the whole cable by that of each of these sub-divisions, as obtained from the 75 values in the Section Book.

If x be the required DR per N.M., reduced to 75° F., and atmospheric pressure, from the measured total DR at sea temperature and pressure as laid; the total DR of part A at sea temperature and pressure will be as follows:—

$$\text{Total DR of A} = \frac{x \times \text{coeff. for } A_t \times \text{coeff. for } A_p \times \text{ratio } A_r}{A_k} \text{ (megs.)};$$

and similarly the

$$\text{Total DR of B} = \frac{x \times \text{coeff. for } B_t \times \text{coeff. for } B_p \times \text{ratio } B_r}{B_k}, \text{ and so on.}$$

Then, because the total measured DR (R) of the cable is equal to the reciprocal of the sum (S) of the reciprocals of its constituent parts at their respective sea temperatures and pressures, we have only to sum the reciprocals of the above values to obtain S. Thus:—

$$S = \frac{A_k}{x\,(\text{coeff. } A_t \times \text{coeff. } A_p \times A_r)} + \frac{B_k}{x\,(\text{coeff. } B_t \times \text{coeff. } B_p \times B_r)} + \text{&c.},$$

or

$$S = \frac{\dfrac{A_k}{\text{coeff. } A_t \times \text{coeff } A_p \times A_r} + \dfrac{B}{\text{coeff. } B_t \times \text{coeff. } B_p \times B_r} + \text{&c.}}{x}$$

But the reciprocal of the above $\left[\text{viz., } \frac{1}{S}\right]$ equals the total DR (R) of the cable at sea temperature and pressure as measured. Therefore

$$R = \frac{x}{\dfrac{A_k}{\text{coeff. } A_t \times \text{coeff. } A_p \times A_r} + \dfrac{B_k}{\text{coeff. } B_t \times \text{coeff. } B_p \times B_r} + \text{&c.}}$$

from which

$$x = R\left[\frac{A_k}{\text{coeff. } A_t \times \text{coeff. } A_p \times A_r} + \frac{B_k}{\text{coeff. } B_t \times \text{coeff. } B_p \times B_r} + \text{&c.}\right]$$

megohms per N.M. (1)

Though I have never met with a complete formula published, I have no claim to priority, as I am acquainted with other electricians who have been in the habit of applying the same principle before I had occasion to embody it in a formula, for my own use, some 16 years ago.

The following are the actual values for a cable 176·5 N.M. in length, laid in widely differing depths and temperatures:

Part.	Length N.M.	Depth, fathoms.	Temperature, F.	Temperature coeff. T.	Depth in fms. × 0·00023 × 2·676 C.	Pressure coeff. = 1 + C	D R ratio at 75° F. r.	Length [N.M.] T × P × r.
A	28 00	16½	76·5	0·89221	0·01015	1·01015	1·2532	24·7900
B	9·00	130	55·0	4·5754	0·08001	1·08001	0·7002	2·6011
C	22·00	487	40 9	13·3669	0·29974	1·29974	0·9935	1·2745
D	106 96	1,401	37 3	17·5354	0·86229	1·86229	1·0012	3·2714
E	7 00	671	40	14·3136	0·41299	1·41299	0·9179	0·3771
F	1·00	180	51	6·2017	0·11078	1·11078	0·4922	0·2949
G	2·50	12½	77·6	0·8206	0·00769	1·00769	0·9296	3·2520
	176·46	947	45·7					35·8610
		Mean						

In this example $S = \frac{35{\cdot}861}{x}$; consequently its reciprocal $\frac{1}{S} = \frac{x}{35{\cdot}861} = R$; where R is the measured total DR of the cable at sea temperature and pressure, viz., 16·335 Ω. Therefore the required DR per N.M. (x) = 16·335 × 35·861 = 586 megs.

Merely multiplying the measured DR 16·335 Ω by 176·5 N.M., and correcting this value for the pressure of the mean depth (947 fathoms) and the mean bottom temperature (45·7° F.) gives only 196 Ω per N.M. at 75° and at atmospheric pressure, which the core value in the factory, as well as tests made immediately before paying out, show to be widely different from the true value. Such a low value might well cause anxiety to anyone unacquainted with the real cause of this disparity.

The result would have been higher still and nearer to the true DR per N.M. had the cable been sub-divided into a greater number of parts and each separately reduced; but the above evaluation sufficiently explains the method and its importance.

A coasting cable, *laid at a uniform depth* and corrected for the mean calculated temperature and pressure, should give approximately the same DR as the factory value, as would also a very long cable in deep water where the bottom temperature does not vary very greatly below a certain depth, but the DR value at 75° should in this case also be determined by correcting the deep sea and shore portion *separately* for temperature and pressure, including also in the calculation their DR ratios (r) at 75° F.

The value of the correction is, of course, most appreciated at the time when the cable is laid, as it is then important to know whether the insulation has fallen during paying out. The foregoing explanation also accounts for an apparent decrease in the measured DR, when the inner mass of a long cable, coiled in the ship's tanks, is at a different temperature to that of the top and bottom flakes, and of the outer circumference, when passing through cold or warm latitudes.

In connection with this subject Mr. J. Elton Young refers to a cable in the factory having the following different temperatures, and a measured total DR = 9·0 megohms:—

23· N.M. at 62° F. coeff. 2·7)
45· „ 55° F. „ 4·7 } DR per N.M. at 75°
120· „ 50° F. „ 6·9)

$$= 9\left(\frac{23{\cdot}}{2{\cdot}7} + \frac{45{\cdot}}{4{\cdot}7} + \frac{120{\cdot}}{6\,9}\right) = 320 \text{ megohms.}$$

This formula—as far as it goes—is correct; but it does not include the difference which often exists between the DR per N.M. at 75° of the core of the several parts; nor does the correction for pressure find a place.

As the reduction for temperature is, however, correct, it is remarkable that in the same paragraph (138, p. 211) Mr. Young, in giving the expression for the *mean* temperature of the cable, should say that "its corresponding coefficient may be applied to the whole length." This statement is, of course, at variance with the formula he has immediately before given, and is incorrect; because the DR coefficient for the *mean* temperature gives, as already pointed out, a very different result (292· Ω) to that obtained by correcting the several parts by their coefficients separately (320· Ω).

In this instance it will be noticed that the temperatures do not differ very much.

Again:—On page 219 the data of a laid cable are as follows:—

90 N.M., in 85 fms., temp = 67° F. : DR at 75° = 1·1 megs.
700 „ 1,350· „ „ = 48° F. „ = 1·4 „
110 „ 130· „ „ = 65° F. „ = 2·2 „
} = Total DR at 75° F. 0·4813 megs.

Mean temp. = 52° F.; coeff. = 5·934 : Mean pressure = 1,074· fms; coeff. = 1·776.

"The corrected DR at sea temperature and pressure will therefore be 0·4813 × 5·934 × 1·776 = 5·072 Ω."

Both theory and experiment show that this calculated value, as here given, cannot be correct; for if, when the temperatures differ greatly, the measured DR divided by the coefficient for the mean temperature gives a result much too low at 75° (as already shown), it follows that the coefficient (and therefore the mean temperature) is too high, and should not be employed to reduce the measured DR to its 75° value. Conversely, this coefficient gives a higher value than would be obtained by measurement when we calculate what DR the laid cable will have by applying the mean bottom temperature coefficient to its true 75° value. Each portion must be corrected separately, for temperature and pressure; and the ratio (r) for the DR per N.M. should also be included in the full formula—see equation (1).

In dealing with this subject Mr. Kempe also furnishes a correct formula for reducing the measured DR of a cable, laid in different temperatures, to 75° *in sections*; but he follows it with the remark that "instead of correcting each

section from its actual to the required temperature, in the way shown, we could assume that the whole length had a temperature which was a mean between the two actual temperatures, and correct the resistances by the coefficient (both for conductor and insulation resistance) corresponding to that mean temperature" (6th edition, p. 475, Section 553).

Strictly speaking, the same principle of correcting the DR for different temperatures *in sections* applies also to the CR. For if r_m is the measured conductor resistance, then the

$$\text{CR per N.M. at } 75^\circ \text{ F.} = \frac{r_m}{\frac{A_t}{\text{coeff. of } A_t} + \frac{B_t}{\text{coeff. of } B_t} + \&c\ldots} \text{ ohms;}$$

but, in the case of the conductor the increase for 1° F. is so small (0·22 per cent.) and so nearly proportional to the increase of temperature, that the employment of the coefficient for the *mean* calculated (or observed) temperature gives practically the same result as when the CR of each part is reduced separately. Hence the latter calculation may be dispensed with, *so far as the conductor is concerned.* With regard, however, to reducing the measured DR to 75°, the very rapid increase (8 per cent. per degree F.) as the temperature falls—or 36 times as much as for copper—introduces a very serious difference in the result when the coefficient of the *mean* temperature is employed, instead of reducing each part separately by its own coefficient.

QUADRUPLEX TWO-STAGE AIR COMPRESSOR.

A QUITE new form of air compressor has been perfected by Messrs. Reavell & Co., Ltd, of Ipswich. It possesses features of such novelty as to make it quite a distinct step in advance in air compression.

In the first place, it is direct-driven by an electric motor. In the machine inspected and tested by us, the compressor is double, each compressor consisting of four two-stage cylinders set round a ring casing, and connected each by its own rod to one crank. As the cranks of the two machines are at an angle of 45°, there are eight waves in the curve of moments, and the only fly-wheel energy required to convert the turning moment curve into a nearly true circle is that of the armature of the motor itself. This feature makes the compressor of peculiar interest at present. In mining work especially, it is far better to carry an electric cable round a mine than to carry air pipes from a compressor on the surface. Usually, however, a compressor is so long and ungainly, that there is no convenient room in which to place it. The new compressor is so compact, and occupies so little space, that it can be placed near the working face, and the air used directly from the compressor.

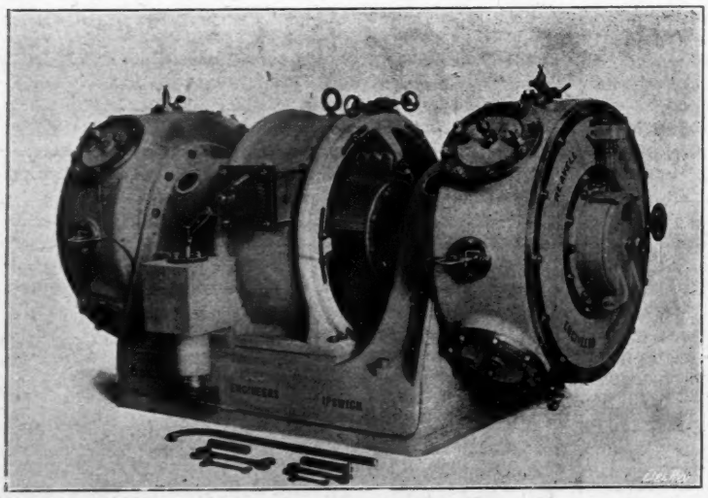


Fig. 1.—The Reavell Motor-Driven Air Compressor.

The latest machine is designed for pressures of 100 lbs., and upwards. The large cylinders are placed next the crank-pin, and the small cylinders are cast in one with them. The air is first compressed between the two pistons, the ratio of which is 4 : 1, so that the compression in the first cylinder is three-fold. All the air-delivery valves of each cylinder are alike, and consist of a light steel cup in a gun-metal case. The necessary valve area is given in any case by varying the number of valves employed—not their size. Thus the valves are wholly interchangeable, and no error can be made in sending off spares. The cylinders are set round a ring casing containing water. The air compressed in each first-stage cylinder is sent through copper worms to the second-stage cylinder opposite, thus effectually cooling it before the second stage. It is then delivered to an annular passage communicating with the delivery ports in the ring frame. The whole compressor is carried on two long bearings, with the motor between, the shaft of which is finished to form coupling flanges to connect to the compressor shafts. The crank-pins are lubricated from an external oil feeder.

Clearance is reduced to a minimum, an important feature in high-pressure work. A common method of testing compressors is to set them to work pumping up a reservoir from atmospheric pressure to 80 or 90 lbs., or other selected pressure. This system is wrong, both theoretically and practically. Messrs. Reavell's method is first to fill an intermediate reservoir to the full test pressure, and then to allow this to escape through a valve into the measuring vessel. The compressor always pumps against the maximum pressure, and the full loss of the clearance space is thereby set against the compressor. In spite of this, however, the efficiency in free air is over 90 per cent. of the piston displacement. Leakage of air past pistons and valves is the commonest loss in compressors. In the Reavell system the piston ring is cut and turned to the cylinder and is kept against it by two spring rings, the cut joints of the three rings not coinciding, and leakage is a minimum.

There are two systems of governing employed, according to the class of work to be done. With pneumatic tools the air pressure must be kept as regular as possible, and the motor is governed by an automatic field regulator controlled by the pressure of air and arranged to vary the speed of the motor to suit the pressure.

For colliery work where a considerable range of pressure may be allowed, there is an automatic starting and stopping device arranged to run the compressor at full speed until the air reservoirs are filled, and to stop it until the pressure has fallen to the minimum. The system of regulation to be employed depends upon the nature of the machines to be driven and the regularity of the pressure that is necessary.

The regulator is simply an air cylinder, with a heavy weight and lever. If a limit of 5 lbs. pressure is fixed upon, the air cylinder and weight are proportioned to act at that limit to throw the field switch over the stops of its rheostat, or a portion of such stops. The device acts very well: with 5 to 10 lbs. pressure variation, the motor will range from half to full speed, thus varying the air supply from 150 to 300 cb. ft. per minute. The pistons are all single-acting only, but, nevertheless, the crankshaft turning moment is never reversed.

The removal of a bonnet or flange in the ring casing opposite each cylinder enables every valve to be got at for removal. Each connecting rod can also be removed at a given position, and the whole of a quadruplex compressor consists simply of two moving parts to each line of cylinders, namely, the connecting rod, and two pistons, cast together, and of the crankshaft, valves and casing, and all moving parts are alike and interchangeable. Indeed, the four connecting rods of cast-steel are simply boréd out as one four-armed

spider, their eyes bored in a jig on a face-plate, and the four rods are then separated by slitting the boss into four segments, which become the crank-pin ends of the rods. The main bearings are carried in a removable shell, and can be changed at any time, so putting the compressor into accurate alignment automatically, as though new again.

Ring oiling is provided, and the whole machine is calculated to run a long time without attention.

One of these two-stage compressors designed to give 300 cub. ft. of air per minute gave the following results:—One end alone was tested. The first stage cylinders were 10 in. diameter × 4⅛ stroke, and the speed 240 revolutions per minute. A vessel of 37 cb. ft. capacity was filled in 87½ seconds through a throttled resistance of 82 lbs. per square inch. This represents 138·7 cb. ft. per minute, the volume swept by the piston being 154 cb. ft., and the efficiency therefore 90·3 per cent. These and the following figures have been confirmed by Mr. W. H. Booth at a recent test.

Another test made on the very usual method of pumping the air into a vessel at atmospheric pressure only and finishing at a pressure of 82 lbs. gave 145·6 cub. ft. of free air at 242 revolutions per minute, the time taken being 90 seconds. The piston volume being 155·1 cub. ft., the volumetric efficiency is 94 per cent. It will be observed that by this method of testing the efficiency of a bad machine with large clearances would come out very much better than by the first method. The fact that so little difference is found between the two methods in the tests of the Reavell compressor is evidence of two important facts—first, that the clearance space is very small; and, secondly, that there can be practically no leakage past the pistons or valves.

The second method, of course, is wrong, for it does not represent the conditions under which compressors work in practice, and it enables a poorly-designed compressor to show results that would not be secured under constant pressure conditions.

The reason why clearance space is so detrimental to economy arises, of course, from the fact that this space is filled with air at the pressure of compression; when the compressing piston retreats to take in a fresh charge of air, the clearance air expands to atmospheric pressure, and if the clearance is large, may entirely fill the cylinder at that pressure. Clearance thus determines the maximum pressure that it is possible to attain. Thus a clearance of 5 per cent. will limit the maximum compression to 20 atmospheres, and will render the compressor very inefficient at a much lower pressure than that. At low pressures a little clearance, more or less, is of very much less importance. Hence the benefit of two-stage compression. In a two-stage compressor, with 3 per cent. clearance in the first cylinder, and a first stage compression of 3 atmospheres, the loss will be 9 per cent., the clearance air occupying, when at atmospheric pressure, three times the clearance space. The clearance of the second stage is of le s importance, but should not be abnormal, and attention should always be paid to reducing it to a minimum.

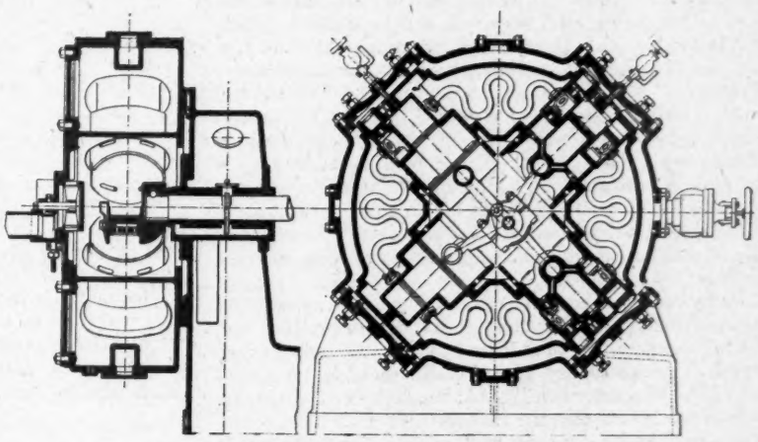


Fig. 2.—Reavell Air Compressor—Cross-Section.

CORRESPONDENCE.

Mr. Swinburne's Dynamo.

Referring to your excellent remarks on Mr. Swinburne's Presidential Address, I was surprised to read that the idea of applying the vernier principle to dynamos was new to you.

About 10 years ago a fellow student (named Casson) at the Central Technical College suggested it to me.

I attempted to apply it to the so-called "unipolar," or commutatorless type of dynamo (as well as to ordinary dynamos and continuous current transformers), so as to obtain a sufficiently high voltage for ordinary working, and thus banish the commutator "for ever," as St. Patrick banished the snakes and toads from Ireland.

But a difficulty at once presented itself.

In continuous current machines of any type the brushes remain fixed relatively to the field, and if the field is caused to rotate (on this vernier principle) at an enormous speed, the brushes must rotate at the same speed, unless they and the commutator are worked on the vernier principle also, so that the points of contact rotate as quickly as the field. Hence I concluded that the idea was impracticable.

However, this conclusion is apparently incorrect, and Mr. Swinburne is to be congratulated for pointing out this method of increasing the output of dynamos, and I hope also of dispensing with the commutator.

Ad. H. F.

Holywood, co. Down, *December 22nd*, 1902.

Gas Engines for Central Stations.

In the interesting article on gas engines for central stations in your issue of December 19th I notice that the generating costs at King's Lynn and Leyton are quoted, presumably as typical of a producer gas station.

But are not these figures a great deal higher than they should be?

I believe Mr. Dowson claims to run gas engines of 50 B.H.P. and upwards by his producer plant for 1 lb., or less, of anthracite per brake horse-hour, and I think it is generally admitted that this is substantiated in practice.

Now, anthracite pea-nuts cost about 23s. per ton delivered in London siding, which corresponds to 8 lbs. of fuel for 1d. (anthracite peas are a little cheaper, but, as a rule, not so suitable as the pea-nuts).

With a reasonably efficient electric generator, therefore, the consumption of coal should not exceed 2 lbs. per unit generated, which would bring out the fuel cost per unit generated at ·25d. only.

But these costs of King's Lynn and Leyton are given at ·98 and ·68 respectively; whence arises this great discrepancy?

Even if, as I suspect in the case at King's Lynn, the ·98 represents fuel cost per unit sold instead of per unit generated, there is still a big loss to be accounted for somewhere, and the important point is, where?

Producer Gas.

[Our correspondent has, perhaps, overlooked the fact that in electric lighting stations, with the usual low power factor, the plant cannot be run continuously at full load. The coal consumption with first-class steam plant is not uncommonly 6 to 10 lbs. per unit generated.—Eds. Elec. Rev.]

A Suggestion.

As the combined transmitter and receiver for the telephone—attached to the latter by cords—is becoming of common

use, it is desirable to have a short name for the combination. It has been variously styled—

1. The transmitter.
2. The receiver.
3. Hand-combination.
4. Micro-telephone.

And several other undescriptive and inappropriate names.

I would suggest for consideration—

"The converser,"

being the apparatus by which the user *converses* with his distant correspondent.

H. W. Jenvey,
Telegraph Engineer and Chief Electrician.

Commonwealth of Australia,
Telegraph Engineer's Branch, General Post Office,
Melbourne, *November 25th*, 1902.

Canopied Cars.

It was a curious coincidence that the letter from "Progressive Manager" on "Runaway Cars" and the illustration of the Huddersfield "D.-D. car" with a cover should appear simultaneously in the same issue of our "guide, philosopher, and friend," because just having read on one side of the page on which his letter appeared, and in which he states that in his "opinion Bellamy's latest edition—the new roof canopy—gives cars an ungainly, top-heavy, and unattractive appearance," my first glance at the illustration of the car, which is on the other side of the page, gave me the impression that it was an ordinary "D.-D'er.," carrying the body of another of its type, which had been the victim of a collision, and had, in being jerked off, lost its lower extremities—the wheels—and had then been hauled up on the top of its relative, which converted the latter into a resemblance of a funeral hearse carrying the remains to the cemetery (car shed) for the obsequies.

In my opinion it has not only an unattractive appearance, but really looks as melancholy as the solemn equipage just alluded to, and a scriptural inscription on the ends (having in mind the possibility of collisions), such as "Abandon hope all ye who enter here," would be admirably appropriate.

I cannot believe that the manager can have perpetrated such a monstrosity; it must be the result of the influence of his committee, or members of it, after a "deputation spree" (which are so frequent and so eagerly sought after) to Liverpool.

Retrograde.

The Sugden Boiler.

The article published in the Electrical Review of 19th inst., illustrating and describing "Sugden's" improvements in water-tube boilers does not explain what means, if any, are provided for working the boilers without superheat.

In all central stations it is frequently desirable to run the boilers without superheating, as, for instance, where a battery of boilers are all supplying steam to a main header, it is found that three out of five boilers give the degree of superheat required.

The boiler can be easily fitted with a bye-pass or equalising valve, so that the amount of superheat may be regulated, but under various circumstances it is occasionally necessary to work without superheat.

Might I also suggest that in conjunction with the straightening of the headers, these and the uptakes should be enlarged, so as to give a carrying capacity nearly equal to that of the total number of horizontal tubes expanded into each.

This would completely remove any tendency to restriction of circulation and improve evaporation and efficiency.

The Sugden boiler is, in my opinion, a combination of the principles embodied in the Babcock-Wilcox and Stirling boilers, with improvements on both.

J. C. Stewart.

Partickhill, *December 29th*, 1902.

[We fear that the large headers proposed by our correspondent would be considered unduly cumbersome. As regards superheat, the boiler can be arranged to employ mixtures with saturated steam, if necessary, to moderate the degree of superheat.

Of course, the position of the superheater is the weak point in all water-tube boilers of this type, but it is rarely indeed that it need be out of circuit. About 10° F. of superheat are lost for each metre length of steam pipe, so that excessive heat is not apt to reach the engines.—Eds. Elec. Rev.]

Supplier and Consumer.

Referring to your article in last week's issue under the heading "Supplier and Consumer," in which you refer to our case, it appears to me that your legal correspondent has not fully grasped the import of this.

He has overlooked, or was not aware of the fact, that the Finchley Urban District Council only saved themselves from a general injunction restraining them from interfering with our wires by filing a "rejoinder" in the High Court, in which they disclaim any right to interfere with wires stretched across highways, provided they are erected in accordance with their bye-laws, and with the consent of the adjoining owners, and provided the Council do not possess the fee simple of the road in question.

Therefore, broadly speaking, this case confirms previous rulings that the consent of the highway authority is not necessary for the stretching of wires across highways, for as a rule they do not possess freehold rights; only so much of the surface and soil is vested in them as is necessary for the purposes of the road.

Of course, if the local authority have at any time purchased a strip of land for road widening, and have taken a conveyance of it, they become the freeholders thereof, and as such possess freeholders' rights up to the sky; if they do not possess the fee simple, their jurisdiction does not extend beyond the zone of reasonable user; 30 ft. has been held to be beyond their jurisdiction.

I may add that the question as to whether the Finchley Urban District Council are, or are not, possessed of the fee simple of the particular highway in question, still awaits settlement in the Appeal Court.

For the Finchley Electric Light Co., Ltd.,
M. W. Woods.

London, *December 23rd*, 1902.

Electrolytic Meters.

Would you allow us, as manufacturers of motor-meters, a few words in reply to the communicated article on "Electrolytic Meters" appearing in your issue of December 19th last.

We take it that this article is written by some one directly, or indirectly, interested in pushing the sale of electrolytic meters, and, accepting the motto "live and let live," we are willing to make full allowance for the appreciation of the would-be seller, but we think that some of the statements go a little beyond ordinary trade appreciation.

For instance, the direct statement that Beecham's pills are worth a guinea a box may be passed, whilst an equally direct statement as to their particular action or otherwise on the system would have to be challenged. So the statement that "there is nothing 'messy' in the operation of refilling a Bastian meter," and that the voltage drop is "practically negligible," and that they are "infinitely superior to any motor-meter in prime cost and permanent accuracy," may be safely left to the discrimination of the buyer. But the statement that motor-meters are wasteful, and the reflection on the length of their life, and the suggestion that their price compares unfavourably with the electrolytic meter, goes a little beyond fair play in the direction of depreciating competitors.

As a matter of fact, our motor-meter consumes no current, and so far from involving a fall of 2½ volts, does not involve so much as half a volt, and there are thousands of our meters that have been in constant use for the last 10 years, and are still quite serviceable. It appears to us, therefore, that it is a little anticipating the future to say that a meter which has only been known to the public for

about three years, has a longer life than one which has been in constant use for 10 years. Whilst as to its accuracy, it is a well-known fact that this entirely depends on the condition of the chemicals used. It is frequently assumed that all electrolytic meters are accurate. This assumption is apparently based upon the maker's statements, or upon results of isolated experiments on selected samples. Its acceptance can only be due to the fact that electrolytic meters cannot be tested for accuracy by the easy and effective means that are applied to motor-meters.

The fact is, electrolytic meters of various kinds have had repeated and lengthy trial. The older types have failed, and at present we can only predict the future from the past. The modern electrolytic meter is a new thing, like all new things it is on its trial, and at present no more can be said than has been said for many other new meters that have since retired to the scrap, namely, that it offers many interesting possibilities.

For Chamberlain & Hookham, Ltd.,
JOSHUA BROWN, *Secretary.*

Birmingham, *December 24th*, 1902.

[We have pleasure in affording our correspondents an opportunity for putting forward the other side of the question. We wish to point out, however, that to the best of our knowledge the writer of the article in question is quite disinterested in the matter, and is not connected with the manufacture of electrolytic meters. Further, the article was specifically confined to small consumers' installations.—EDS. ELEC. REV.]

Re Single-Phase Electric Railways.

Our attention has been called to the letter appearing in your issue of the 26th from Mr. J. W. Hall in which we are charged with having made incorrect statements with regard to what he calls his *hydraulic* variable speed gear. Mr. Hall appears to be under a misapprehension, for our letter to you had no particular reference to his gear. In fact, of the oil variable speed gears described by Mr. Swinburne, we were most impressed with that given in fig. 7 of his paper, which is not Mr. Hall's gear.

It is hardly necessary, therefore, for us to refer to the two points as to which Mr. Hall would correct us, as they appear to lie in his imagination only.

We gather from your correspondent's concluding remark that he did not share with us the good fortune of hearing Mr. Swinburne deliver his address, otherwise he would have appreciated the difference between the oral and the printed.

Geipel & Lange.

December 30th, 1902.

OZONE WATER PURIFICATION WORKS AT WIESBADEN-SCHIERSTEIN.*

IN order to demonstrate the practicability of the application of ozone for the commercial purification of water, Messrs. Siemens & Halske some time ago put down an experimental plant at Martinikenfelde, the results of which were so successful that the methods there worked out have now been put into operation on a large scale at Wiesbaden. Wiesbaden in the past has been supplied with two water systems, one for dietetic and the other for manufacturing and other purposes. The source of the latter supply is at Schierstein, and it is this which is now to be treated by the new process, so that in the future both supplies can be combined for all purposes.

The plant put down has a capacity of 250 cb. metres per hour, but as the normal demand is only 125 cb. metres, the plant is divided into two parts so that only in exceptional cases is it necessary to run both halves; as all parts are interchangeable, it is possible to use part of one half with part of the other in case of the breakdown of any detail.

The works are divided into three parts, the engine room, ozone chamber and sterilising room.

In the engine room are two 60-H.P. condensing locomotive engines, two alternating, and two continuous current belt-driven generators, and the continuous current motor-driven water pumps and air blowers. Of the 60 H.P. available, 27 H.P. is required for the generation of ozone and 22 H.P. for the pumps.

The alternating current is converted to the necessary high voltage by six step-up transformers, from whence the current flows to 48 ozone generators. These generators are divided into two sets of 24, each fed by three transformers, and are arranged on shelves, one above the other. The generating apparatus used is of the Siemens-Halske metallic tube type, the characteristic construction of which is that one of the discharging surfaces is cooled by circulating water. The apparatus is contained in cast-iron cases with plate-glass sides, so that the "silent discharge" can be clearly seen and any disturbance at once detected.

The ozone generator proper consists of eight glass tubes in parallel, cooled by water, and eight concentric metallic tubes covered with a coating of an ozone-proof material. One pole is formed by the glass cylinders, which are connected firmly to the outer casting, and earthed by the cooling water, while the concentric metallic cylinder is the other. This construction results in great safety in working, so that during the running any apparatus can be taken out and replaced with ease. Each apparatus weighs about 80 lbs. (40 kgm.).

The air passes into the ozoniser undried, from thence to the sterilisation towers, whence, after passing through the falling water, it returns to the ozoniser again. By means of an automatic valve, enough fresh air is taken in to make up for the oxygen used up.

The supply of water to the sterilisation towers is controlled by a valve which shuts off the supply directly anything goes wrong with the supply of ozonised air to that tower. The towers are about 4 metres high, and contain a layer 2 metres thick of coarse gravel, through which the water is caused to trickle, meeting the ozone from below.

In order to avoid the possibility of any disturbance of the proper action of the plant, causing unpurified water to get through, a very complete system of safety devices is employed. As soon as one of these devices acts, an indicator is thrown down on the central indicator board in the engine room, and a bell is caused to sound.

A no-current automatic device is included in the primaries of the transformers, on the action of which, due to failure of the electric current, an electrically-controlled water valve is closed, shutting off the supply of water to the towers in series with that transformer.

The ozonised air flowing through the pipe acts upon a hanging vane, which is kept up by the normal pressure; should the latter fall, the vane descends and makes an electrical contact, which likewise shuts off the water supply to the particular part affected. Every ozoniser is provided with an indicating device and alarm signal, which acts should a short circuit occur due to water leaking from the middle to the lower part of the apparatus. This device is very simple, and consists of a strip of filter paper stretched by means of a spring and resting on the glass bottom of the chamber; as soon as this paper gets wet it is torn, and contact is made in the alarm circuit.

Owing to several circumstances the Schierstein-Wiesbaden installation does not offer a fair opportunity for the determination of the comparative costs of the ozone process; but as far as can be at present determined, allowing for interest on capital and depreciation, and assuming a production of 250 cubic metres per hour, they amount to 0·25d. per cubic metre. Assuming a production of 125 cubic metres per hour (*i.e.*, 50 per cent. reserve plant) the costs are 0·28d. per metre.

As regards the chemical and bacteriological character of the water, the results obtained are excellent, and confirm those previously obtained—that the process gets rid of absolutely all pathological bacteria, and that non-pathological harmless bacteria are reduced to mere traces.

This result, that the harmful bacteria are more sensitive to the sterilising action of ozone than the harmless ones, is the great advantage of the new process over the old sand

* Compare article by Dr. Gg. Erlwein in *Gesundheit*, Vol. xxvii., 1902, No. 19.

filtration, as in the latter, the diminution of the number of bacteria present takes place in the same proportion with all germs, thus leaving some dangerous sorts still in the water.

With the starting of the Wiesbaden works, water purification by means of ozone has entered into actual commercial work and rivalry with the older existing processes. Besides the above-mentioned sanitary advantage, the space required for the plant is very small, and the possibility of the exact control and continuous testing of every step is given.

If all that the process promises is realised, there will be no doubt of its future success, especially in those places where only surface drainage can be relied upon for the water supply. C. C. G.

THE CONTINENTAL ELECTRICAL INDUSTRY.

A Banking Credit of £1,500,000 for Five Years. Proposed Teutonic Combination for the Russian Market.

The question of constituting a syndicate of European makers of incandescent lamps has engaged attention for a long time past, but the protracted negotiations between the interested firms in Germany, Austria and Hungary, which countries were proposed as the limit of the combination at the outset, have proved abortive. It was intended as the main idea of the scheme to divide the various markets among the different works for the purpose of securing economy in freights, customs duties and agency expenses, and at the same time effect a moderate increase in prices which, on their present basis, severely affect the makers. Rightly or wrongly, the failure of the negotiations is attributed to the attitude of some of the German makers who were opposed to the restriction in the production which the scheme would have imposed upon them.

German Companies and Matters.

The Allgemeine Elektricitäts Gesellschaft, of Berlin, has come forward with a reduced dividend for 1901—02, although the distribution is satisfactory in view of the general condition of the electrical industry, and has fulfilled the anticipations of the Stock Exchange in Berlin. It is at the rate of 8 per cent. on a capital of £3,000,000, as compared with 12 per cent. on the same amount of capital in 1900—01, 15 per cent. in 1899—1900 and 1898—99, and 15 per cent. on £2,350,000 in 1897—98. The gross profits, which are given in one lump sum without any details, amount to £349,848 for the past year, being a diminution of £186,480 as compared with the preceding year, and of £265,870 as against 1899—1900. The net profits are £281,702, as compared with £486,930 and £535,760 in the two previous years respectively. The result for the year has been arrived at after making the usual provision for depreciation—the machinery, tools and patterns, together with the 125 German and 267 foreign patents, were entirely written off in earlier years—but nothing has been placed to the reserve fund on the present occasion, whereas over £73,000 was devoted to this purpose a year ago, £75,000 in 1899, and £50,000 in each of the two preceding periods. The company's report attributes the crisis in the industry to investment in unprofitable undertakings, deficient examination and over capitalisation of these undertakings, unjustified extension of manufacturing works on the basis of orders given by themselves for their own enterprises, and, therefore, only occurring once, and the extension of business and sale organisations beyond the measure dictated by the basis of manufacture. It is submitted that the importance and future of the electrical industry will not be diminished by these causes, but, on the contrary, that new markets might be opened up by greater assiduity, although an immediate recovery could only take place with great difficulty. The report states that the first thing to be done is to determine without any reserve the disproportion between productivity and consumption, and it suggests in regard to the consolidation of the industry that a more intimate connection between the large firms can scarcely be avoided when the sale prices of manufactures have again been brought to a remunerative level, but a warning is expressed against any undue haste being made in this direction. It was inevitable, the directors remark, that the company should suffer from the depression, but the position would have been much worse if, in opposition to public opinion and individual interests, they had not expressed and followed a business policy for the past five years based upon the anticipation of a reaction. This policy consists in precautions for having available considerable cash or liquid means, in the establishment of strong, visible and internal reserve funds, the complete writing off of the manufacturing plant, a multifarious system of manufacture and the cultivation of foreign business. The company is, therefore, no longer so dependent upon the inland condition of business as formerly, because it has invested considerable capital in remunerative undertakings which stand in the books at a low figure, whilst the securities issued by the company in different markets have also proved profitable. The available means at disposal are said to amount to £1,350,000, of which the greater portion is in cash and the remainder in securities which can easily be realised. The activity of the works is regarded as relatively satisfactory, the number of persons employed, which amounted to 17,361 two years ago and 14,644 12 months ago, having risen to 14,897. The report, which mentions that the output of dynamos and motors is represented by 211,861 H.P., as against 268,100 H.P., next refers to the success of the Nernst lamp, of which hundreds of thousands are now said to be in use, to the work accomplished in wireless telegraphy and to the inauguration of the construction of motor cars in the cable factory.

The Continental Co. for Electrical Enterprises, of Nuremberg—as was mentioned in a Reuter telegram a few weeks ago—is reported to have concluded an agreement with an English syndicate, composed of firms ranking as authorities in railway matters, for the construction of an overhead railway in London on the Langen suspended system as in operation between Elberfeld and Vohwinkel. It is said that the projected railway, which is to be 11 miles long, is to proceed from the "periphery right into the heart of the City," but as the Berlin *Tageblatt* naively points out, the details concerning the exact route are withheld, in order that "the acquisition of the land for the line may not be rendered difficult." Fancy buying land before seeking Parliamentary powers! The syndicate, which has to pay a definite sum for the use of the Langen patents, will undertake the construction of the railway on its own account at a cost of £2,000,000, and the agreement also provides for one-half of the plant and equipment being supplied by the Continental Co.'s parent, the Schuckert Co.

The directors of the Schuckert Co. have had a petty squabble among themselves respecting collective or individual signature on behalf of the company. As four of them considered that their rights were prejudiced by the majority insisting upon collective action in this respect, they have resigned office, but it appears that the position assumed by the other directors was justified by the alteration in the statutes which was made at the general meeting held last August. A considerably more important matter than this is to be found in the attitude of the banking syndicate which has guaranteed the credit of the Schuckert Co. and the Continental Co. for several years past. The syndicate has now approved the financial plans of the two companies, and decided to grant for a further fixed period of five years the necessary credits required for the completion of all the enterprises of both companies. Not only so, but in consequence of the satisfactory information furnished by the directors, the banking syndicate has renounced its right to security being offered by the companies. The significance of this arrangement, which cannot be terminated until the expiration of five years, will be understood from the fact that in the past the total credit placed by the syndicate at the disposal of the companies has amounted to £1,500,000 per annum, and this sum will henceforth be available without the apprehension of withdrawal at the end of each year, as in the earlier periods. One of the immediate results of the new agreement is apparently found in the decision of the companies to at once establish a new company to take over the transfer of the concession obtained for the erection, equipment, and working of a large central station in Warsaw. The Schuckert Co. was under the obligation to proceed with the works or forfeit the sum of 200,000 roubles, and the former alternative is now the order of the day.

The Accumulator Co., of Berlin and Hagen, whose withdrawal several months ago from the syndicate of German storage battery makers is reported to have led to the collapse of this combination, has issued a remarkable circular, which at first appeared to relate to Germany, but which actually concerns the purchasers of the company's type of cell (the Tudor battery) in other countries. The circular deals with a profit-sharing scheme for the company's trade customers in a manner which is novel, at all events in Germany, if not in other countries. After setting forth particulars of rebates to be allowed on sales, and the percentage of which will increase in accordance with an augmentation in the value of the net turnover, the circular discusses the question of participation of clients in the company's net profits. The scheme is based upon the deduction from the gross profits of the whole of the working and other expenses, and provision for depreciation and the allocation of 6 per cent. as interest on the company's capital; whilst out of the balance then remaining 25 per cent. is to be distributed among customers in the proportion which their respective net sales bear to the total net turnover of the company. The latter's balance-sheet cannot be objected to by customers who will also have no right of inspection of the business books. In return for participating in the scheme, the obligation is placed upon clients to sell and recommend only the company's manufactures; other productions can only be selected by express permission of the company. It was reported on November 14th that these conditions had already been accepted as a whole by the Allgemeine Co. and Siemens & Halske, and by the Schuckert Co., with the proviso that other types of batteries might be dealt in, but on the following day the company hastened to deny that any such or similar agreement had been proposed to German customers. The scheme, the company proceeded to remark, had served as the basis of negotiations exclusively for foreign transactions. With this explanation the matter ends for the moment; but even if the company is able to earn 6 per cent. on the share capital, it is incomprehensible that the directors would be able to devote any portion of the net profits to the purpose of distribution among its customers to the apparent detriment of the shareholders.

The Watt Accumulator Works Co., of Berlin, has issued its liquidation balance-sheet for the period ended June 30th, 1902. It shows a deficit of £73,984 on a capital of £75,000. The Phœbus Electricity Co., which is also said to be in liquidation, has increased its debit balance of £5,000 to £44,900 during the past year on a share capital of £65,000. The Electrical Industry Co., of Carlsruhe, which underwent reorganisation at the beginning of this year, has terminated its financial period with a paper balance of £16,000.

RUSSIAN AFFAIRS.

The probability of a working agreement being arrived at by the German companies which are represented by agencies or companies in Russia, and having exclusive reference to the Russian market, is engaging the careful attention of the native electrical firms. Among the Teutonic companies which cultivate trade across the Eastern frontier in this manner are Siemens & Halske, the Union Co., the Allgemeine Co., and the Helios Co. One Russian journal has gone so far as to state that the agreement, which proposes to regulate the production and introduce uniformity in prices for the Russian market, has actually been concluded, and that the effects of the arrangement are already being considered in the circles interested in electrical undertakings in that country. The journal submits that in any case a salutary influence may also be expected on Russian electrical enterprises from the operation of such an agreement, or at least in regard to those which are directly connected with German companies. Apparently the Russian organ has anticipated events, seeing that inquiries made of the leading companies in Berlin have elicited the statement that the agreement "has not hitherto been brought about." Inferentially this reply implies that efforts are being made to arrive at an understanding in the matter, although the question of regulating production for an external market seems somewhat dubious.

The contract which has just been placed in St. Petersburg for the supply of lead-covered cables for the municipal telephone system in that city has evoked indignation on the part of the Russian works which competed for the order. It appears that the greater portion of the contract, which was thrown open to international competition, has been given to the Rheydt Cable Works Co., of Rheydt, Rhineland, through the intermediary of its Hamburg representative, who was present in St. Petersburg at the time. It is possible that the whole of the order would have been secured by the German company had it not been, among other reasons, the desire of the municipal authorities not to allow the two Russian works domiciled in St. Petersburg, which submitted by far the highest tenders for the cables, to retire empty-handed from the contest. Hence it is that the Rheydt Co. has been given the order for two-thirds of the contract, and the remaining third is being equally divided between the two Russian works. Before the competition was settled and when the native firms found that in consequence of the low prices offered the contract was likely to be given to the German company, the two Russian works immediately reduced their quotations to the Rhenish figures, and this is probably the principal reason for a part of the order remaining in the country. The dissatisfaction of the Russian cable makers at the course of events has now found expression in a movement which has as its object the making of representations to the Minister of Finance in favour of a considerable advance in the Customs duty on foreign cables, which already stands on a high basis.

The Russian Schuckert Co., of St. Petersburg, has in no way fulfilled the anticipations which were entertained a year ago. At that time the accounts showed net profits amounting to 143,516 roubles, which would have sufficed for the payment of a dividend at the rate of 5 per cent., but it was decided to reserve the balance for the following year. This precaution has been justified by the results of the past year's trading, which, after taking into consideration the profit brought forward, exhibit a loss of 13,600 roubles.

The Russian Lahmeyer Co., which incurred a loss of 130,000 roubles in 1900-1, has also closed the past year with a deficit of 118,000 roubles.

BUSINESS NOTES.

Some Schmidt Superheated Steam Tests.—Messrs. Easton & Co. send us some test records of an engine 14 in. × 49 in. h.p. and 28 × 36 l.p. cylinder run with and without superheat. The pressure in each case was about 100 lbs., the power 117·4 and 166 for saturated and superheat respectively, and the apparent economy 37·5 per cent. Probably part of this was due to better load conditions, but no doubt can exist that most of it was due to the 102° of superheat, the coal per horse-power-hour dropping from 3·75 to 2·34. Of course this is a case of an old engine using a considerable amount of steam—perhaps rather wet steam—which is now supplied with steam of undoubted dryness. With saturated steam one can never tell how much water is really going over to the engine; superheat cures all that, and there are plenty of cases where steam hardly superheated at all, will show an enormous economy over steam, which may be 10 or 15 per cent. wet. The thermometer will not indicate if steam is wet, or how wet it is, but it will tell us when it is not wet, and how much it is removed from wetness. This is, of course, a positive gain due to superheat, and properly to be credited to a superheater.

Brooke's Oil Extractors.—Messrs. Holden & Brooke, Ltd., of West Gorton, have recently received, amongst other orders for the Brooke's patent completely automatic system of oil extraction, instructions to supply a plant of 4,500-H.P. capacity to the Metropolitan Electric Supply Co., Ltd., London, and one of 4,000-H.P. capacity to the New Kleinfontein Mines in the Transvaal. Each of these plants is to be equipped with Holden and Brooke's patent automatic discharger for ejecting the collected oil under vacuum.

Electrical Wares Exported.

WEEK ENDING DEC. 24TH, 1901.

		Value £
Alexandria		267
Auckland		18
Boca.	Teleg. mat.	80
Bombay		151
,,	Teleg. mat.	60
Boulogne		59
Buenos Ayres		36
	Teleg. mat.	586
Cadiz.	Teleg. cable	209
Calcutta		883
Cape Town		415
Channel Islands		810
Chinde		12
Colombo		128
,,	Teleg. mat.	128
Copenhagen.	Teleg. wire	49
Durban		705
East London		177
Halifax.	Submarine cable	4,200
Hong Kong		242
Melbourne		580
,,	Teleg. wire	4,100
Rosario		35
,,	Teleg. mat.	429
,,	Teleg. instruments	393
Rotterdam.	Teleg. wire	38
Santiago		105
Santos		265
,,	Teleg. mat.	114
Singapore		17
Stockholm.	Teleg. cable	167
Sydney		6,729
Yokohama		160
Total		£22,389

WEEK ENDING DEC. 23RD, 1902.

		Value £
Adelaide		13
Alexandria		21
Beira		447
Bombay		226
Buenos Ayres		325
Calcutta		40
Cape Town		39
,,	Teleg. mat.	70
Channel Islands		21
Christiania.	Teleg. wire	87
Colombo		64
Delagoa Bay		10
Durban		659
,,	Teleg. mat.	3,250
,,	Teleg. plant	2,107
East London		1,403
Flushing		25
Gibraltar		73
Halifax		22
Hobart		915
Hong Kong		16
Kure.	Ships' telegraph	140
Launceston		17
Lisbon		180
,,	Teleg. mat.	50
Madras		16
Mauritius.	Teleg. mat.	72
Melbourne		177
Mombassa		75
Montreal		86
Nagasaki		81
New York		79
Ostend		62
Perth		105
Port Elizabeth		283
Rio de Janeiro		5
Rotterdam.	Teleg. wire	66
Shanghai		392
Stockholm.	Teleg. wire	174
Sydney		767
Trinidad		94
Wellington.	Teleg. wire	3,782
,,	Teleph. mat.	925
Zanzibar		45
Total		£17,835

Foreign Goods Transhipped.

			Value £
Melbourne.	Elec. mat.		300
Calcutta.	Elec. apparatus		18
Halifax.	Elec. mat.		64
Melbourne.	Teleph. goods		87
Total			£169

Electrical Wares Exported.

WEEK ENDING DEC. 31ST, 1901.

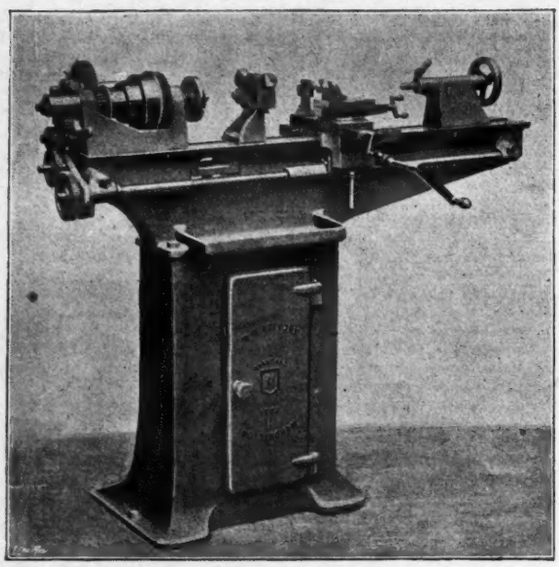
		Value £
Adelaide		514
Alexandria		136
Buenos Ayres.	Teleg. mat.	100
Calcutta		1,237
Cape Town		190
Channel Islands		150
Christiania.	Teleg. wire	51
Colombo		10
Copenhagen		34
,,	Teleg. wire	44
Durban		352
Fremantle		686
Hong Kong		30
Madras		80
Melbourne		95
,,	Teleg. wire	675
Perth		14
Rio de Janeiro		120
Singapore		179
Sydney		849
Total		£5,496

WEEK ENDING DEC. 30TH, 1902.

		Value £
Amsterdam		40
Bombay.	Teleg. mat.	323
Bordeaux		23
Calcutta		2,671
Cape Town		480
,,	Teleg. mat.	1,705
Colombo		22
Durban		13
Fremantle		975
Madras		21
Melbourne		18
Nagasaki		18
Osaka		359
Penang.	Elec. light cables	175
Perth		1,118
Port Elizabeth		172
Rio de Janeiro		21
Singapore.	Teleg. cable	32,670
Sydney		134
Total		£40,959

Electrical Prospects of St. Thomé and Principe.—Consul Nightingale, in his report on the trade and commerce of the Province of St. Thomé and Principe, just published, states that some of the houses in the town of St. Thomé are lighted by electricity supplied by a private concern, which also runs an ice factory, the same engine being used to generate the electricity as is used to make the ice. He thinks there is no reason why the plentiful water-power at hand should not be used in the place of steam. Some of the plantations, he remarks, have their own installations of electric lighting, and he has been informed that a complete system of electric traction is being put down on one of the more important estates, supplied by a German firm. With the large amount of water-power which is distributed all over the island, electricity should, he is of opinion, be generated at a small expense, and it might prove remunerative to an expert, were he to pay a visit especially to advise the planters as to its practicability. The island is also badly in want of some better means of transport than the primitive bullock wagons and black carriers at present in vogue. Here, again, Consul Nightingale thinks an engineer, who has had experience in similar countries, might be able to give most valuable advice as to the best system to adopt, whether that of a light railway, or aerial transport. Catalogues, he states, are all very well for quoting the prices of tools, &c., but when it comes to a question of quoting for the installation of a light railway, or an electric power station, then the presence of the practical man is required to give an estimate of the cost on the spot. An hour's conversation is worth more than months of correspondence, and many planters would no doubt be glad to embrace any system which could be proved to them to be an economical factor in working their estates. All the principal "roças" are connected with the town of St. Thomé by telephone, and the West African Telegraph Co. have a station there, and also at the island of Principe.

Lathe for Electricians.—The accompanying illustration shows a 4½-in. × 4-ft. screw-cutting tool room and electrician's lathe (Standard A 1 model), the smallest of a series, as made by Mr. William H. Astbury, of Wheeler Gate, Nottingham. It is claimed to be neat and compact in design, and to retain the leading characteristics of an English lathe. An important departure, however, is the mounting of the gap bed upon a substantial rectangular pedestal, or column, fitted internally with shelves for



The Astbury Lathe.

storing, and protecting from damage the "tackle" belonging to the machine, the combined dead weights of the column and contents tending greatly to increased accuracy of work, by lessening the chatter and vibration when in use. The upper surface of this column also lends itself admirably to form a solid bearing of ample length, and rigidly supports the bed directly under the gap—its usually weakest point. It is stated that owing to the peculiarity of the design, heavier cuts and stiffer jobs can be more satisfactorily dealt with than on an ordinary 4½-in. lathe.

The Underfeed Stoker.—The Underfeed Stoker Co., of 31, Walbrook, E.C., have sent us particulars of tests made of their stokers fitted to some 8 ft. × 28 ft. Lancashire boilers at the Maybank station of the Potteries Electric Traction Co. There are four boilers in all at this station with 38-in flues, constructed to the specification of Mr. W. H. Booth, without cross water pipes. The salient features of the comparative tests by hand, and by stoker, are, that the consumed in 8 hours was respectively 6,384 and 5,656 lbs., or 22·15 and 19·6 lbs. per square foot per hour. The CO_2 produced was 9·6 and 13·4 per cent., the evaporation was 54,056 and 56,177, or 8·46 and 9·93 lbs. per pound of coal from and at 212° F., and 8·97 and 10·59 per lb. of combustible, also from and at 212°. The increased duty per pound of coal is 17·6 per cent. A further test at 30·6 lbs. of coal per square foot of grate per hour gave 12·8 per cent. of CO_2, 9·34 lbs. evaporation per pound of coal from and at 212°. This underfeed stoker is fed centrally by a helix in a trough. The grates which flank the trough have a sharp incline to each side, and consists of flat bars overlapping like roof slates, the air blown in coming between the bars and blowing over the surface of the grate, so that no air rises too directly through the fire. The air is forced by a fan, and the stoker works without smoke production.

Würtemberg (Germany).—Dr. Frederick Rose, His Majesty's Consul at Stuttgart, in his report on the trade of Würtemberg for the year 1901 and part of the year 1902, refers to the general commercial depression in Germany during the period under review, and remarks:—"The electro-technical industries, which had contributed so much to the period of prosperity by the rapidity and extent of their advance, have, perhaps, suffered most severely from the industrial reaction. The causes for this may be found in the decline of the demand and the great increase in competition. Shares in electric works and prices had already declined considerably during the latter half of 1900, and this downward movement was steadily continued during 1901. The export trade to the United Kingdom, France, Italy and Russia remained about the same. The wish is freely expressed that the State should now, instead of later, place the orders, which are sure to come, in order to assist the electrical branches over this critical period. The manufacturers of small special articles of the electro-technical branch showed better results than the manufacturers of electric plant and machinery, and the export in these articles, which are mostly patented, showed no decrease compared with previous years."

King's College.—The Lent term commences on Thursday, January 15th, as announced in our advertisement pages to-day.

An Oscillating Ventilating Fan.—Messrs. Hinstin Frères, of 19, Rue Droust, Paris, have introduced a little novelty in the shape of an oscillating electric ventilating fan. It consists of an ordinary electric fan mounted on a special bedplate. The current serves only to rotate the fan in the usual way, so that no extra current is needed. In front of the fan-blades are mounted three vertical blades, and it is the action of the air on these which causes the whole fan to oscillate. Adjustable stops are provided by means of which the degree of movement can be regulated. It is claimed that the fan has the advantage over the ordinary type, that it distributes cool air in all parts of the room instead of only in one direction.

Rosling & Fynn, Ltd.—The debenture-holders of this Bradford firm have entered into possession of the assets. The company announces that it has been compelled to suspend operations owing to a want of working capital. Recently the firm erected extensive new works at Thornbury, where a thoroughly up-to-date plant was laid down capable of a large output. The company, of which the first directors were Mr. P. Rosling (chairman), Mr. W. H. Appleby, and Mr. V. A. Fynn, was registered in June, 1900, as Rosling, Appleby & Fynn, Ltd., to acquire the business then carried on at Trafalgar Works, Trafalgar Street, by Messrs. Rosling & Appleby, and the name was changed to the present style in the following year, Mr. Appleby having retired from the business. The authorised capital was £100,000, in shares of £1, half being 6 per cent. cumulative preference (having also priority as to capital) and half ordinary; and £15,000 preference and £27,000 ordinary shares have been subscribed and paid up, the ordinary shares having been issued to the vendors. There was also power to issue debentures up to £15,000.

Life Guards.—We understand that Messrs. Witting Bros., Electrical Engineers and Contractors, Ltd., have recently placed with the Tidswell Life-guard Co., of Bradford, an order for 50 complete sets of life-guards of their own well-known standard type.

St. Louis Exposition, 1904.—The Röntgen Ray Society of America and the Inter-State Independent Telephone Association have promised their co-operation in assuring representative exhibits of these two departments of electrical science.

Improved Protractor.—An extremely neat circular protractor has been designed by Mr. F. S. Snowdon, by means of which a considerable amount of reference to tables is obviated, and much time saved. The protractor bears in addition to the ordinary divisions, the trigonometrical ratios for each degree from 0 to 90°, arranged radially at the corresponding angles. Thus, practically all the constants required for ordinary purposes in connection with any angle, are at once available in the handiest possible form; further, the space inside the graduated circle, usually wasted, is in this instrument usefully occupied by additional data, and by millimetre and inch scales, and is pierced so as to combine with the protractor a couple of small set squares. The instrument should have a warm reception in drawing offices.

Supper.—On Tuesday, December 23rd, a supper was given at the Exchange Hotel, Manchester, by Mr. Nicholson to mark the close of a most successful year's working of the business of R. J. Nicholson & Co., electrical installation engineers. After supper an interesting concert was contributed by members of the staff and friends, during the progress of which a number of toasts were suitably honoured.

Institution of Gas Engineers.—The Incorporated Gas Institute and the Incorporated Institution of Gas Engineers have been dissolved, for the purpose of forming a united Society under the name of the Institution of Gas Engineers. The Institution has been duly registered, the offices being at 39, Victoria Street, Westminster.

Electric Mining Machinery.—The *Manchester Courier* says that the Great Laxey Mine Reconstruction Co., after examining the electric plant at the Greenside Mine, are thinking of establishing electric machinery for pumping out the Great Laxey Mine at a cost of about £20,000.

Long Life of a Switch.—We have received from Mr. Lundberg a switch of the old boxwood base, spring-break type, once so familiar in the days of Woodhouse & Rawson and their contemporaries: the switch in question is fitted with a fuse under the same wooden cover, and the latter is fixed on with a couple of screws, being considerably larger than the base of the switch. This has been at work for nearly 18 years, and, though somewhat the worse for wear, is still in a thoroughly serviceable condition.

Bankruptcy Proceedings.—A receiving order has been made in the Manchester County Court, on the debtor's own petition, against William Scholes, electrical engineer and contractor (Scholes and Son, at 85, Corporation Street, Manchester, and 10, Rochdale Road, Middleton).

A receiving order was made on December 22nd, on a creditor's petition, against A. E. Pemberton, electrical engineer, of Ashton-on-Mersey.

The public examination in bankruptcy of T. E. Morgan, electrical engineer, of Sheffield, stands adjourned until January 15th.

Dissolutions and Liquidations.—A meeting of the shareholders of the Coventry Lighting and Engineering Co., Ltd., was held at the Queen's Hotel, Coventry, on Monday, for the purpose of considering a resolution for the voluntary winding-up of the company. Mr. H. W. Robinson presided. A balance-sheet showing the company's position up to September 30th was presented. The loss on 15 months' trading amounted to £2,719 10s. 6½d., and this, with the cost of the liquidation of the said company and reconstruction, made a deficiency of £3,970 14s. 5½d. The chairman, in moving the resolution that the company be wound up, said that in his opinion the causes of failure were lack of working capital, the unsaleable nature of the stock-in-trade, heavy interest and establishment charges, and an insufficient turnover. The directors had done all they could to try to restore the concern, but without success. They had also endeavoured to sell the business as a going concern, but were unsuccessful in that, and there appeared to be no alternative but to wind the company up. Mr. W. Lee (Coventry) seconded, and said he was satisfied that this was the only course they could adopt, as the company was losing money. Alderman Andrews (Coventry) agreed with the proposal, and said there seemed to be something in the atmosphere of Coventry that made it impossible to run a joint stock business successfully. The chairman mentioned that the directors would be the heaviest losers. The proposition was carried unanimously, and Mr. A. J. Cudworth, chartered accountant, Birmingham, was appointed liquidator.

The Davy Electrical Construction Co. meets at 18, Bishopsgate Street, E.C., on January 26th, to hear an account of the winding-up from Mr. Geo. Frampton, liquidator.

A similar meeting of Messrs. Laing, Wharton & Down, Ltd., will be held at 80A, Coleman Street, E.C., on January 28th (Mr. L. B. Warmington, liquidator).

The Telegraph Manufacturing Co. meets at Liverpool, on January 26th, for a similar purpose (Mr. W. H. Alexander, liquidator).

The Simplex Electric Tramway Conduit Syndicate is winding-up voluntarily, with Mr. B. Cookson, of 6, Castle Street, Liverpool, as liquidator.

The B.E.T. (Pioneer) Co. is also winding-up, with Mr. C. H. Dade as liquidator.

Messrs. T. E. Boothby and R. Fishwick, jun. (Boothby, Fishwick and Co., electrical and general engineers, of Hollinwood), have dissolved partnership. Debts will be attended to by Mr. Fishwick.

Trade Announcements.—Messrs. Saxby & Farmer, Ltd., notify that the businesses hitherto carried on independently by themselves and Messrs. Evans, O'Donnell & Co., Ltd., of Chippenham, Wilts., have been amalgamated, and will in future be carried on as one concern under the name of Saxby & Farmer, Ltd. Mr. Charles Hodgson (chairman), Mr. A. G. Evans, and Mr. J. B. O'Donnell are joint managing directors. The factory at Chippenham which has been acquired is thoroughly equipped with modern machinery and labour-saving appliances, and it is now being enlarged to accommodate the joint businesses. In view of the constantly increasing cost of manufacturing in London, the company will, as soon as possible, remove the factory from London to Chippenham, retaining the present offices at Kilburn, where the joint staffs will be accommodated. It is also intended to retain at Kilburn a portion of the present factory for urgent work, repairs and stores for finished articles. Under the terms of the amalgamation, Messrs. Saxby & Farmer, Ltd., are to receive all debts owing to, and discharge all liabilities owing by, Messrs. Evans, O'Donnell and Co., Ltd.

It has been announced that Messrs. Gebr. Koerting, of Hanover, are going to convert their concern into a joint-stock company, to which the management of the business is to pass from the 1st inst. The capital of this company is likely to be about 15 million marks. The electrical department of the firm will not be included in the conversion contemplated, as by the terms of a convention with the Berlin Allgemeine Elektrizitäts Gesellschaft, it will pass into their hands. This company will take a considerable share in the stock of the new company, and great advantages, it is hoped, will be derived from this transaction for the company named.

Messrs. Connolly Bros., Ltd., of Blackley, Manchester, have appointed Messrs. Saunders, Todd & Co., of Maritime Buildings, King Street, Newcastle-on-Tyne, as their agents for the Northumberland, Durham and Tees district.

The Sloan Electrical Co., Ltd., of 15, Fore Street Avenue, E.C., has been appointed agent for the Hydra Werke Electrical Co., Ltd., of Berlin, for its dry batteries for telegraphic, telephonic and bell purposes, and also for automobiles.

Calendars and Catalogues.—We are indebted to the ELECTRICAL POWER STORAGE Co. for one of their excellent desk pads and diaries for 1903. It is beyond doubt the most convenient thing of its kind that reaches us in the course of the year, and we believe that large numbers of electrical engineering and commercial men find it very serviceable. We have also received a pocket price list of the E.P.S. lighting and traction cells.

The GENERAL ELECTRIC Co., LTD., has brought out a wall calendar in the shape of the "Angold" arc lamp. It is a handy little thing with weekly tear-off sheets.

A small illustrated pamphlet of Premier iron-clad switches, cut-outs, rheostats and circuit breakers, has been issued by MESSRS. E. P. ALLAM & Co., of 11, Hatton Garden, E.C.

MESSRS. MAVOR & COULSON, LTD., have sent us one of their wall calendars for 1903.

MESSRS. ROYCE, LTD., have sent us their usual stock lists of d.c. dynamos and motors for December.

We have received from the *Chemical Trade Journal* (Blackfriars Street, Manchester) one of their wall calendars, with monthly tear-off sheets, for 1903.

MR. T. W. WARD, of Sheffield has brought out a "Special Purchase" illustrated catalogue and price list of about 250 new modern machine tools (one-half American), which he has for disposal from stock.

Catalogue No. 54 of MESSRS. R. W. BLACKWELL & Co., LTD., contains a note of prices, particulars, and also illustrations of a variety of tramway and carshed tools and car supplies.

A neat and handy pocket diary has come to hand from the SIMPLEX STEEL CONDUIT Co., LTD., of Bucklersbury, E.C. The first few pages consist of an abridged price list of their well-known specialities, of which a new catalogue is now in the press.

We are once more indebted to the BRUSH ELECTRICAL ENGINEERING Co. for their very serviceable little diaries for the waistcoat pocket.

Two new pamphlets have been issued by the HORSFALL DESTRUCTOR Co., LTD., of Leeds. One is a new edition of their destructor list, and gives pictures and brief tabulated data respecting destructor plants set up by the company in different parts of the world; the other is devoted to the "Loidis" smoke-consuming forced-draught furnaces and steam blowers.

MESSRS. T. BOLTON & SONS, LTD., are circulating their excellent "Record" Pocket Diary and Note Book for 1903, with convenient self-registering pencil.

A convenient desk blotting pad with top pocket has come to hand from the HART ACCUMULATOR Co., LTD., of Stratford.

The latest electrical section (abridged) of the illustrated catalogue of MESSRS. P. R. JACKSON & Co., LTD., of Manchester, contains a number of half-tone views of their several types of dynamos and motors and motor-generators, electric pumping and haulage machinery, and a few general details regarding the same.

MESSRS. NALDER BROS. & THOMPSON have sent us one of their usual wall calendars with monthly sheets.

ELECTRIC LIGHT AND POWER NOTES.

Belfast Power Scheme.—A Bill has been lodged in the House of Lords to obtain powers for the "construction of electrical generating stations for the production, transformation, and distribution of electrical energy over the manufacturing counties of Antrim, Down, and Armagh." The Bill provides for the acquisition of a considerable area of land on the banks of the Belfast ship channel, and also on the Newry Canal at Newry, on the River Bann at Portadown, and at Ballymena. The electrical power generated at these stations will be distributed over the three Ulster Counties for manufacturing, traction and lighting purposes. It is also contemplated to "electrify" the inland canal extending from Newry to Portadown, and the navigation of the River Lagan. The Bill provides for the electrifying of existing tramways and railways.

Briton Ferry.—The D.C. has appointed Messrs. Lewis and Fletcher, Cardiff, as consulting engineers for the designing of the plant for the supply of electric light for the town.

Boston (U.S.A.).—A turbine plant will be furnished by the United States General Electric Co. to Massachusetts electric companies which control a number of electric railways, and operate some 18 power stations in the vicinity of Boston. This plant will include 10 turbine sets to develop about 2,000 H.P. each. It is also reported that the General Electric Co. has contracted to instal either two or five very large turbine sets in the power plant of the Edison Electric Illuminating Co., of Boston, commonly known as the Boston Edison Co. These machines are expected to develop approximately 10,000 H.P. each. It is understood in the trade that the Schenectady works of the General Electric Co are being fitted as rapidly as possible for the production of turbines on a large scale. It was with this object in view that heavy purchases of machine tools were made.—*Engineering.*

Cardiff.—The Corporation has decided to provide slot meters for small consumers of electricity, at a charge of 6d. per unit, so as to avoid the payment of 13s. 4d. per quarter for meter rent, to which there were much objection.

Chatham.—The Lords of the Admiralty contemplate making extensive use of electricity in Chatham Dockyard for the purpose of lighting the workshops and for driving all the lighter machinery. It is believed that the change will be the means of effecting considerable economy.

Chipping Norton.—The T.C. has decided to oppose the application of Mr. W. V. M. Popham for a prov. order for the supply of electricity to the borough.

Left to its own Devizes.—The T.C., after considering the application of a private syndicate for a prov. order for electric lighting, has resolved to apply for a prov. order itself.

Dartford.—The E.L. Committee has recommended that the charge for electricity should be reduced from 8d. to 7d. per unit for the first hour's use per day, with 2d. per unit afterwards. The U.D.C. has, however, asked the Committee to consider an optional flat rate.

A report on public lighting shows that when gas was used £805 was spent annually for a candle-power of 9,424; with electricity the cost for 18,136 C.P. is £1,027.

Delhi.—On December 4th, says the *Times of India*, Lord and Lady Curzon and the Viceregal suite visited the Dewan-i-Am to inspect a full-dress rehearsal of the electric light installation. The roads within the Fort were illuminated by 35 2,000-C.P. arc lamps, and the Dewan-i-Am was brilliantly illuminated with 80 groups of ceiling cluster incandescent lamps—in all 750 16-C.P. lights. A group of 53 is hidden behind and within the great Mogul Throne, revealing to the fullest extent the beautiful mosaic work behind this masterpiece. Round the cornices are fitted some 500 additional lamps. These will be reserved for the ceremony of the Investiture alone. Then, indeed, this great hall will be brilliant beyond all conjecture. Afterwards the electric lighting in the Dewan-i-Khas was initiated. "The effect was superb; it was a scene from the Arabian Nights, Shah Jehan's lovely paradise had acquired a newer beauty. The gold and lapis lazuli work glowed with a lustre it had never known before. The picture beggars all description, and Captain Halliday and Mr. Allison have earned the thanks of all Durbar visitors for this exquisite treat."

Ealing.—On Tuesday last week Col. H. J. Hepper held a L.G.B. inquiry relating to the application for sanction to borrow £17,881 by the T.C. for the purpose of electric lighting.

Falkirk.—Nearly all the principal shops and offices in Falkirk are being wired for the electric light, which is expected to be ready for use about February, and the hands of the local electricians are full. While the applications made for lamp connections have been up to its expectations, the Lighting Committee is not satisfied with the number of orders for motive power, and has resolved to reduce the price of electricity for power purposes from 3d. to 2d. per unit.

Fife Electric Power.—The draft prov. order of the Fife Electric Power Co. has now been issued. The persons named in the order are Sir Ralph W. Anstruther, Bart., Sir James Sivewright, D. Russell, R. Russell, A. Sanderson, J. Pringle, J. A. Hood, W. Robertson, J. A. Dewar, W. Stowe, B. M'Laren. The capital of the company is to be £600,000, in 60,000 shares of £10 each. The area of supply is to be the whole of the County of Fife. Energy will be supplied only in bulk to authorised distributors, and for providing power to any person. In the schedule the sites proposed to be taken by the company at Comrie (Culross), Cowdenbeath, Cupar, Markinch and Leven are described. Where the company charges any consumer by the actual amount of energy supplied to him, it will be entitled to charge him at the following rates per quarter:—(*a*) For any quantity not exceeding the equivalent of 400 hours of supply at the maximum power, at the rate of 3d. per unit; (*b*) for any further quantity at the rate of 2d. per unit.

France.—La Compagnie Générale d'Electricité, of Paris, reports a profit of only £12,636 for the last financial year, as compared with £51,430 in the preceding 12 months. No dividend is being declared.

Huddersfield.—The L.G.B. has sanctioned a loan of £5,000 for the purchase of motors and electric appliances.

Kirkcaldy.—On December 23rd the electric light was successfully switched on, and the town was lit up by the new illuminant from end to end of the tramway route.

Kirkintilloch.—The T.C. has resolved to apply for a prov. order for the supply of electricity within the burgh. From the report submitted to the Council by Mr. A. W. Stewart, Glasgow, it appears that to light the town and provide a two-cell refuse destructor (the heat from which would generate the steam for a 112 H.P. engine) would cost £10,900.

London.—CAMBERWELL.—The Guardians have resolved that £1,000 be spent for electric lighting and other requirements at the infirmary buildings.

A special committee of the St. George's Guardians has engaged Mr. T. J. Digby to report as to the installation of electric light at the workhouse for a fee of 20 guineas.

BATTERSEA.—The Council is now supplying equivalent to 19,843 8-C.P. lamps. This shows an increase of 3,409 8-C.P. lamps during the quarter. In addition, the Council supplies motive power equivalent to 228 H.P., which is an increase of 115 H.P. in the three months.

North Seaton.—Public lighting by electricity has been introduced here, current being supplied from a colliery in the parish.

Norwich.—The T.C. has decided to issue stock for raising £210,000 for the purchase of the undertaking of the Norwich Electricity Co., Ltd, and for the construction of additional works.

Macclesfield.—A private company has been formed with the object of taking over, by agreement, the Corporation's prov. order.

Margam.—The electric lighting scheme for the district, prepared by Mr. Prusmann, of Swansea, has been adopted by the U.D.C. The estimated cost of the scheme is £15,000.

Mexico.—A Laffan telegram from New York, dated December 27th, says:—"The correspondent of the *New York Times* telegraphs from Mexico City that Sir Weetman Pearson & Son, the English contractors, have procured a concession to establish an electric generator, at a cost of $12,000,000, in the mountains of Puebla, where there is abundant water power, to transmit a current of 80,000 H.P. to the city for commercial uses."—*Times*.

Midlothian.—The village of Blackburn, near West Calder, Midlothian, has just been lighted by electricity by the West Calder Co-operative Society. The society, which has a large number of members in the district, has erected the arc lamps and is supplying electricity to the village free of charge. The generating plant has been installed in the society's branch premises in the centre of the village.

St. Albans.—The T.C. is negotiating with the North Metropolitan Supply Corporation for the provision of electric light for the city.

St. Austell.—The National Electrical Wiring Co., Ltd., has informed the U.D.C. that it has been asked to purchase the E.L. undertaking at St. Austell, and that in order to put the works into a satisfactory condition for supply, an expenditure of £7,000 or £8,000 will have to be incurred in relaying and extending mains. The company considered that the matter should be taken up by the Council; the company would be willing to carry out the necessary work provided the Council supplied the capital, and would be willing to work the scheme, agreeing to hand the whole concern over to the Council on receiving certain notice. The Council has referred the matter to a committee for consideration.

Sittingbourne.—Two companies are applying for powers to supply electricity to the district, and with the object of securing favourable terms, the U.D.C. has decided to confer with Milton U.D.C. on the matter.

Spain.—Application has been made to the Spanish Government for a concession to put down a plant to utilise the water-power of the river Cinca in the generation of electrical energy for lighting and power purposes at Barbastro and Huesca.

Stafford.—The R.D.C. has approved of the proposal of the T.C. to obtain a prov. order for the extension of the Corporation's electric lighting system into parts of the parishes of Leighford, Castle Church, Tillington, Hopton, and Coton and Berkswich.

Stewartstown (Co. Tyrone).—The Council is considering the advisability of lighting the streets with electricity.

Totnes.—At a meeting of the T.C. on December 24th it was stated that Messrs. Crompton & Co. had deposited £500 with the B. of T. with a view to the Council's E.L. order being transferred to them.

Walton-on-the-Naze.—The U.D.C. has authorised an agreement with the Coast Development Co. for supplying the public lamps of the town with electricity at a cost of £2 15s. per annum for each 16-C.P. lamp.

Warsaw.—According to *Sell's* the municipality intends introducing electric lighting for the entire city, and there is also some hope of the electrification of Warsaw tramways, which the municipality took over a few years ago.

West Bromwich.—The gas and electric departments are about to fit up and compare their respective systems of lighting on the tramway poles in the High Street. The experiment is to be continued for a period of three months at the cost of the Highway Committee. At the end of this time reports as to the cost are to be submitted by the respective departments.

Willington (Salop).—The U.D.C. has decided to include in its Parliamentary Bill powers to supply electric fittings, to allow discounts on payment for supplies of electricity for lighting or power purposes, and to exempt the Council from liability to supply electricity in certain cases.

Wimbledon.—The U.D.C. has decided to supply electricity for lighting the L. & S.W. Railway station at 3d. per unit for a minimum consumption of 50,000 units per year.

ELECTRIC TRACTION NOTES.

New York.—Our New York correspondent writes: 'The severe frost of the second week of December interfered seriously with the traffic of the newly installed 'third-rail' service on the New York Elevated Railway. The snow and sleet froze to the conducting rail as it fell, according to some accounts, destroying the insulation, or, according to others, preventing the brushes acting properly. Anyhow, the scrapers which the company had provided against such an emergency proved quite inadequate, and the whole of the elevated traffic was suspended at the busiest time of the evening. At one point the passengers became so infuriated that they attacked the ticket office, demanding return of their fares, the police having to be called to restore order, and charge the crowd with their night sticks. Among the suggested remedies for the avoidance of this trouble is a proposal to place the 'third rail,' which is placed outside the near-side rail, in a vertical position, or to melt the ice by means of a travelling heater attached to each train."

Plans are now completed for the construction of a trolley line from Hartford to New Haven, thus connecting New York and Boston with a continuous line of electric street cars.

The City Board of Aldermen, in addition to authorising the Pennsylvania R.R. tunnel beneath the Hudson, have also sanctioned the construction by the New York and Jersey Railway Co. of a tunnel designed for street car traffic. The company has taken over the assets of the Hudson Tunnel Co., which suspended operations after spending $4,000,000 on the construction of about 4,000 ft. of a tubular tunnel from the Jersey side, a rock having been reached about 1,400 ft. from the proposed New York City terminus. It is estimated that another $6,000,000 will be needed to complete the tunnel. The terms for the granting of the franchise are that the company pays 3 per cent. of its gross earnings to the municipality for the first five years and 5 per cent. thereafter. The traffic in the tunnel will be operated entirely by electricity, and will be for passengers only.

Manchester.—The tramway receipts of Manchester are on an ascending scale. During the week ending December 20th, the weekly receipts, for the first time, exceeded £8,000. On one route alone, the newly-opened one between the city and Palatine Road, Withington, a sum of £1,150 was received in fares. An even larger amount was received on the Manchester and Stockport route. Our correspondent says that no doubt is now entertained that the £30,000 which the Tramways Committee estimated they would be able to pay to the city treasurer in relief of the rates during the current municipal year will be forthcoming. When the entire system is in full working order, the financial benefit to the ratepayers will be very much greater. For the week ending Saturday last, December 27th, the revenue was £8,484, and the number of passengers carried 1,795,106. The Tramways Committee of the Corporation, at a meeting on Tuesday last, had under consideration the conditions of service under which their men are working. In response to the men's petition, their working hours are to be reduced from 60 to 54 per week. This applies to all grades of the service. There will also be a slightly increased weekly wage. The new conditions are to take effect on April 1st.

Mersey Tunnel Railway.—The first two cars out of the full equipment of 57 for this railway reached Rock Ferry station on Friday last. The cars delivered are first-class cars, 60 ft. long. Each of the end compartments will seat 22 persons, and the middle compartment 16 persons, making a total of 60, which will be the completement of the first-class trailer cars. Third-class trailer cars will accommodate 64 persons. First-class motor cars will accommodate 48 persons, and third-class 50 persons. There will be no second class. The cars are being made by Messrs. G. F. Milnes & Co., Hadley, and the motor cars, as completed, are being sent to the Westinghouse Co.'s works at Trafford Park for the motors and brakes to be fitted. The Westinghouse compressed air brake will be provided on the cars. As regards working, a sectional sub-division of the tracks has been adopted, so that in the event of a temporary failure of current, one section only would be affected. No change is being made in the signalling system lately in use on the Mersey Railway. Electric lamps will be fixed in the tunnel for staff or emergency purposes, and the cars will be well lighted with 16 c.p. incandescent lamps. A three minutes' daily service between Liverpool Central Station and Hamilton Square, the station at Birkenhead nearest to the River Mersey, and a six minutes' service between Liverpool Central and Rock Ferry and Birkenhead Park stations, outlying stations of the Mersey Railway, will be maintained; the electrified service will extend to Birkenhead Park station. To meet the competition of the electrified Mersey Railway, the Liverpool—Birkenhead steamboat service will be improved, and the Birkenhead electric car service will be re-arranged.

Canterbury.—The Light Railway Commissioners have submitted to the Board of Trade for confirmation an order authorising the construction of a railway between Canterbury and Herne Bay.

Central London Railway.—A stoppage occurred on this railway shortly after 4 o'clock on Monday afternoon necessitating the suspension of the service between the Bank and Museum stations. It was stated that a train had fouled a crossing, blocking both lines.

Belgium.—A company has just been registered in Brussels with the title of the London and Paris Electric Syndicate, Ltd. The capital consists of seven 1-franc shares, and there are 1,000,000 founders' shares of 25 francs. The company's object is to establish a system of electric transportation between London and Paris!

Chatham.—It is stated that on December 19th, under the auspices of Major Pringle, of the Board of Trade, a series of trials to test the Westinghouse tramway brake, which is to be fitted to all the tramcars upon the Chatham system, was made here. The brake was tested under severe conditions, and came through successfully.

Dover.—The scheme for a mono-railway from London to Dover will not be proceeded with this year.

Dundalk.—The Privy Council, sitting at Dublin Castle on December 16th, decided conditionally to grant an extension of time for the completion of the tramways in and near Dundalk by the Dundalk Electric Tramway Co.

Gloucester.—The Tramways Committee has recommended the engagement of Mr. Dickenson, of Birmingham, as consulting engineer for the construction of the City electric tramways. This appointment will include the advisory services of Mr. Hammond (who is associated with Mr. Dickenson in tramway work) in the electric equipment of the line.

Halesowen.—The D.C. has obtained the sanction of the Light Railway Commissioners to borrow £75,000 in order to construct light railways between Hasbury, Blackheath and Birmingham, which will give direct communication between Stourbridge and the Midland city. It is stipulated that the whole of the railways will have to be completed within three years.

Heckmondwike.—The B.E.T. Co. has agreed to pay the U.D.C. £1,200 per annum for a supply of 160,000 units for the trams, the rate per unit being a fraction over 1¾d. The agreement is for 28 years, subject to a revision at the end of half that period. The Council hopes to make an annual profit of £200 on the transaction.

Lancaster.—The tramway engineer (Mr. W. A. Tester) has been instructed to prepare plans for an extension to the tramways from Dalton Square terminus *viâ* Common Garden Street, King Street, Meetinghouse Lane, Station Road, and West Road, to the corner of Willow Lane, to tap this populous neighbourhood.

Leigh (Lancashire).—A Bill to be promoted by the Corporation of Leigh in the coming session of Parliament seeks, amongst other things, power to construct about five miles of additional tramways, and the widening of some of the streets along which the lines are to be laid.

Manchester and Liverpool Mono-rail Scheme.—This scheme, which is to provide rapid transit between the two cities, seems to be hanging fire. The promoter, Mr. Behr, is said to have informed a Press representative this week that the company has not yet decided upon any contract for the construction of the line, or any part of it, and it is not known when any active step will be taken.

Leighton Buzzard.—The Light Railway Commissioners have submitted to the Board of Trade for confirmation an order for the construction of a light railway from Leighton Buzzard to Hitchin.

Light Railways.—The B. of T. has confirmed the following Light Railway Orders:—Crowland and District Light Railways (Amendment) Order, 1902, amending the Crowland and District Light Railways Order, 1898; North Shields, Tynemouth and District Light Railways (Extension) Order, 1902, authorising the construction of a Light Railway in the Urban District of Whitley and Monkseaton, in the county of Northumberland.

Macclesfield.—A Bill promoted by the Macclesfield and District Tramways Co. will come before Parliament next session, giving the company power to construct about 18 miles of tramway lines between the present terminus of the Stockport tramways and the towns of Macclesfield and Bollington. The object is to provide an electric tram route, in conjunction with the Stockport and Manchester tramway systems, right out to the beautiful country around Macclesfield. The line as proposed will be mostly single, and will run through the parishes of Poynton and Adlington, with branches off the main road, at Butley, to Bollington and Prestbury. From Butley the line is to be continued to the centre of Macclesfield. The line will command a large holiday traffic during the summer months, and is certain to be remunerative. Power is also to be taken to convey cattle and goods over the intended lines.

Middleton.—The electric tramcar service between Manchester and Middleton was inaugurated last week. The cars are provided by the Manchester Corporation, but the lines in the borough of Middleton are owned by the Middleton Corporation, Manchester having taken a lease of them for 21 years. The Middleton Corporation also supplies the current within its own area, on terms equivalent to those charged by the Manchester Electricity Committee for tramway purposes. The route is about six miles long, and the fare charged between the city and borough is 3½d.—somewhat less than the third-class fare by railway.

New South Wales.—The *Montreal Star* says that Mr. O. W. Brain, electrical engineer to the Board of Railway Commissioners for New South Wales, arrived in Montreal on Decem-

ber 14th, in order to inspect the chief railway centres of Canada. For some time past Mr. Brain has been visiting the railway centres of Great Britain and the Continent, with a view of gathering the latest information in the way of new electrical appliances. In discussing the railway situation in New South Wales, Mr. Brain pointed out that at the present time there are 4,000 miles of railway, 120 miles of electrical tramway and about 30 miles of steam street railway in the country, all of which was controlled by a railway commission. That this had proved a benefit to the country was shown by the fact that public opinion in the country was more strongly in favour of State-owned railways than ever before.

Russia.—The municipal authorities of St. Petersburg have decided to raise a loan of 30,000,000 roubles for the purpose of constructing a system of electric tramways in the city.

St. Annes.—The U.D.C. has arranged terms for the supply of current for that portion of the new electric tramways between Blackpool and Lytham which is in St. Annes, and in consequence the plant at the electricity works is to be extended. The supply is to commence in May next.

Shipley. — The last meeting of the D.C. approved an agreement with the syndicate which is proposing to run a line through Shipley from Keighley to Ilkley. It was reported that it was still found impossible to make satisfactory arrangements with the Bradford authorities.

Solihull. — By eight votes to six the R.D.C. has assented to the Bill of the B.E.T. Co. for the provision of electric trams in the district. Yardley Council has come to a similar decision.

Whitehaven.—The R.D.C. has given its assent to the application of the West Cumberland Tramway Co., for an extension of time and revision of the terms of the Bill of 1901.

West Indies.—Sir C. C. Knollys, Acting-Governor of Port of Spain, opened the electric tram system which runs around the Queen's Park, Savanna. The length is about three miles.

Salford.—The whole of the tramways in this borough are now electrified, Eccles, Pendlebury, Swinton and Prestwich have all leased their tramways to the Corporation, and a provisional agreement has been entered upon with Whitefield for the working of the tramways in that district, while negotiations have been opened with Radcliffe. So far, however, they have failed to come to an agreement with Manchester, as to an interchange of traffic, though it is possible that a mutual satisfactory agreement may be arrived at in the near future.

TELEGRAPH AND TELEPHONE NOTES.

Madeira.—A report of the American Consul to the *Reichsanzeiger* states that Funchal City, in spite of its great population and the large area it extends over, so far lacks a public telephonic service. Business, as a rule, is therefore carried on by means of letters and messengers, though some of the prominent firms have private telephones of their own. The different localities of the island communicate with Funchal by telegraph and letter-post. A line leading to the lighthouse on Cape San Lorenzo serves the purpose of signalling the steamers coming from the North about three hours before their arrival. Postal deliveries take place thrice a week, the letter-bags being conveyed by messengers on foot. There is therefore a good opportunity for installing telephones and additional telegraph services.

Telegraphic Interruptions and Repairs :—

Cables.	Interrupted.	Repaired.
Latakia-Cyprus	.. June 20, 1899 ..	..
Trinidad-Demerara No. 1	.. Aug. 27, 1900 ..	..
Trinidad-Demerara No. 2	.. Nov. 3, 1902 ..	..
Dominica-Martinique	.. May 7, 1902 ..	..
St. Lucia-Martinique	.. May 7, 1902 ..	..
Guadeloupe-Martinique	.. May 7, 1902 ..	..
St. Lucia-St. Vincent	.. Nov. 18, 1902 ..	..
Martinique-Puerto Plata	.. July 10, 1902 ..	..
Guantanamo-Mole St. Nicholas	.. Aug. 4, 1902 ..	..
Cayenne-Pinheiro	.. Aug. 13, 1902 ..	..
Assab-Massowah	.. Dec. 30, 1902 ..	..
Santa Cruz de Teneriff to Tejita de Teneriff	.. July 4, 1902 ..	..
Reissi-Issa	.. Oct. 22, 1902 ..	..
Reissi-Yemani	.. Oct. 22, 1902 ..	..
Sivebondo-Bandjermasin	.. Nov. 25, 1902 ..	..
Zanzibar-Mombassa	.. Nov. 25, 1902 ..	..
Cadiz-Teneriff	.. Nov. 3, 1902 ..	..
Landlines :—		
Majunga-Tananarive	.. Nov. 29, 1902 ..	..
Route to Tientsin and Taku *vis* Helsingfors	.. June 18, 1900 ..	..

Manchester Telephones. — The Manchester Mutual Telephone Co. held its annual meeting last week, Mr. George Saxon presiding, when a report was presented with reference to the position of the movement for establishing a competitive telephone system for the city and district. The Mutual Co. was called into existence some years ago, when a good deal of dissatisfaction was felt with the local telephone administration; but nothing of a practical nature has yet been determined upon. The directors, at the meeting referred to, recommended the continuation of the company's existence until the result of the action which is being taken by the Corporations of Manchester, Salford and Stockport has been declared. The meeting adopted the report and the directors and auditors of the company were re-appointed.

Spanish Telegraphs. — The report of the Spanish Minister of Posts and Telegraphs for 1901 has just been issued. It shows that the overhead telegraph wires now extend to a distance of 72,000 kilometres, an increase of 29 010 kilometres over 1900; the length of the underground wires 591 kilometres, and of submarine cable 4,300 kilometres.

CONTRACTS OPEN AND CLOSED.

OPEN.

Atherton.—January 23rd. Switchboards, transformers, pillars and cables. See "Official Notices" to-day.

Barrow.—January 5th. Two 250-KW. steam generators, switchboards and piping. See "Official Notices" December 5th.

Belgium.—January 7th. The Belgium State Railway Authorities at La Bourse, Brussels, are inviting tenders until January 7th for the supply of two compound continuous current dynamos, each of 15-KW. capacity, one shunt wound continuous current dynamo of 23-KW., one shunt wound electric motor of 11½-KW. and one 8½-KW. dynamo, all to work at a pressure of 115 volts.

Bermondsey.—January 19th. Lamp columns, arc and incandescent lamps, switch pillars, &c. See "Official Notices" to-day.

Bristol.—January 6th. Surface condensers for Avonbank station. See "Official Notices" December 19th.

Bulawayo.—February 26th, 1903. Establishment and working of an electric tramway. See "Official Notices" Nov. 21st.

Colchester.—January 17th. Wiring, &c., for Essex and Colchester Hospital. See "Official Notices" December 26th.

Dundee.—January 17th. Electric lighting switchboard, boosters, balancers and switch gear for the Corporation electrical power station. See "Official Notices" to-day.

Fulham.—January 14th. Two electric passenger lifts for the Guardians. See "Official Notices" to-day.

Glasgow.—January 5th. 100 electric motor equipments and spare parts. See "Official Notices" December 12th.

Guayaquil.—February 12th. The following are the terms, as quoted by the New York *Electrical World*, for the contract for lighting the city:—(1) The city to be lighted by gas or electric light, or both, within limits provided for in the contract. (2) The lights to be located 3·5 metres (3·8 yards) above the surface and 1 metre (1·09 yards) from the houses' front (portales), and not be farther apart than 35 metres (38·1 yards). (3) Each light to be of 15·4 C.P. (international unit); at the intersection of the streets in the central part of the city, the lights to be of 80 C.P., located at a height of 6 metres (6·5 yards). (4) The Council guarantees that it will take at least 1,400 lights during 11 hours daily, also 50 lights of 80 C.P., for which payment will be made monthly. (5) The municipal engineer and the inspectors of lights shall take the usual measures to test the quality of the lights in any part of the city. (6) The gas or electric conductors must be laid underground, and of the most modern system and size.

Hull.—January 21st. 15 double-deck single-truck cars, equipments and top covers. See "Official Notices" to-day.

Ipswich.—January 23rd. 26 electric cars, also one for street cleaning, watering and sanding. See "Official Notices" to-day.

Lowestoft.—January 7th. Motor cars, trucks, motors, and equipments, and track sweeping and watering car. See "Official Notices" December 12th.

Portugal.—January 7th. The Direccion Generale de Altramar in Lisbon is inviting tenders until the 7th inst. for the supply of 30 tons of galvanised iron wire, 4 mm. diameter, a quantity of copper wire, Leclanché batteries, &c., for the telegraph and telephone service in Mozambique.

Partick.—January 6th. Arc lamp columns, arc lamps, mains, &c. See "Official Notices" December 19th.

Salford.—January 10th. Two battery boosters for Strawberry Road Station. See "Official Notices" to-day.

Southend.—Jan. 6th. Wiring municipal buildings, &c., for electric light. See "Official Notices" December 26th.

Spain.—January 23rd. Tenders are being invited until the 23rd inst. by the municipal authorities of Alcaniz (province of Teruel) for the concession for the electric lighting of the town during a period of 10 years. Tenders are to be sent to El Secretario del Ayuntamiento del Alcaniz (Teruel), whence particulars may be obtained.

(Continued on page 25.)

ELECTRIC POWER IN SHIPYARDS AND WORKSHOPS.

At the Engineering Congress held in connection with the Chicago Exhibition, there was read a paper entitled "The Planning and Equipment of Modern Ship and Engine Building Plants," which gave a complete and satisfactory comparison of the methods then in use for the application of power over large manufacturing areas. At that time, though the electrical power industry was only in its infancy, it was already making its influence felt, so that Prof. Durand felt constrained to devote a section of his paper to the consideration of the novelty. He did not then, however, come to any definite conclusion as to which was the best system of power transmission, returning an open verdict after a most thorough discussion of every system then in use.

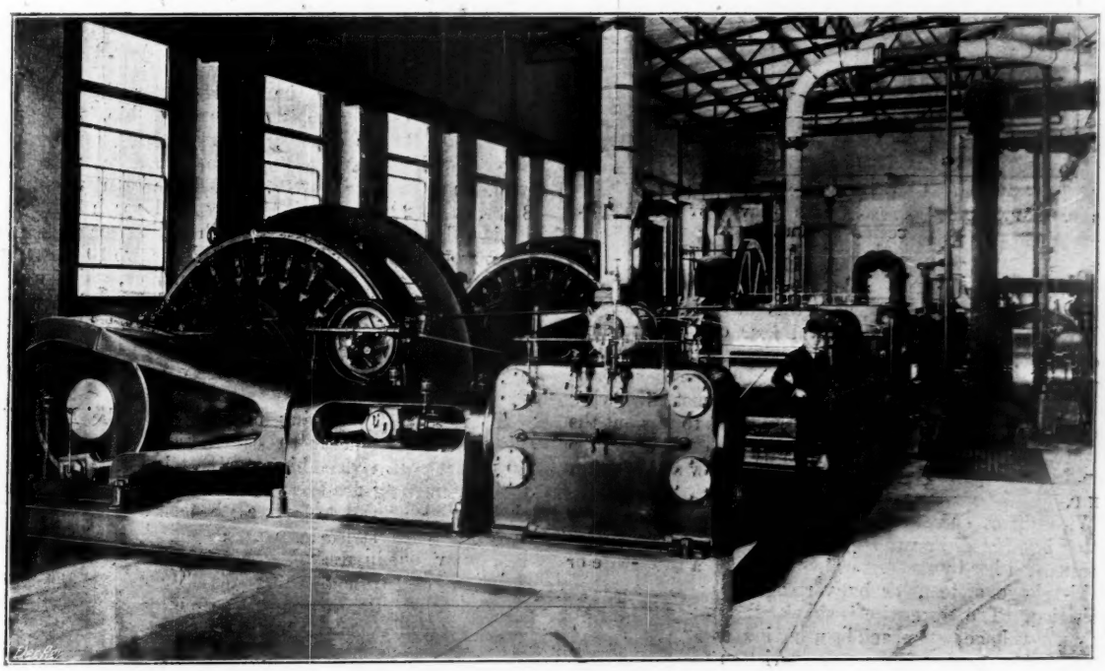


Fig. 1.—Power House of the New York Shipbuilding Co. Showing Westinghouse Double-Current Generators.

Since the time when this paper was read, the strides made by electricity have been gigantic, and in no direction has its development been more remarkable than in its application for purposes of power distribution in workshops, factories, mines, &c. Thus it comes to pass that nowadays there is no question as to which system of transmission is preferable; electricity is acknowledged to have proved its claims, and the argument is rather about the manner of its application.

Transmission by shafting and belt or rope driving is, as everyone knows, most inefficient, the loss by friction in the journals, slip of belts, &c., being anything up to 80 per cent. of the power generated by the engine. It is inelastic, it causes much vibration, and the multiplication of belts in a crowded shop often seriously hampers the operators. Moreover, the lighting is interfered with, and the use of cranes sometimes becomes very inconvenient. Some of these latter facts are even more important than the lack of economy. It must be remembered that in only a very few instances will the cost of power be as much as 10 per cent. of the total cost of production, so that a reduction of 20 per cent. in the former will only mean a net saving of 2 per cent. But the electrical distribution system escapes the other disadvantages of the older methods. The space required for the transmission lines is so small that they can always be kept out of the way. There is no trouble from leakage or heat. The loss due to heating of the wires is quite inconsiderable for ordinary workshop distances. Where the machines are large enough to require separate motors, belting is almost entirely done away with; when the machines are smaller, a few are operated from a motor-driven countershaft, and belting is reduced to a minimum. A solution of the problem of only using power when work is to be done is attained, for, even with group driving, the groups can be so arranged that it is very unlikely that even a whole group will have to be driven to work one tool, whereas formerly the whole shop often had to be driven in a similar case. The efficiency is very high, that of an average electrical equipment being 70—75 per cent.

It was at first thought that, in places such as cement works, grain elevators, mines, &c., where the air is full of dust and grit, motor driving would prove impracticable, but the difficulty was soon met, first by the construction of enclosed motors, in which all parts—such as the commutator—which would be affected by dust were completely shut in; and later, by the invention of the alternating current induction motor, which has no commutator or slip rings, and is only vulnerable in its bearings, which can easily be protected. In a grain elevator at Buffalo, motors of this type were often run with the chaff from the grain coming above the shaft, so that the moving part was actually rotating in the chaff; no harm whatever resulted to the motors.

The question of speed control of motors is a most important one. If the speed of the tool can be altered by varying the speed of the motor itself, the very important advantage of the abolition of gearing is secured. On the

other hand, it must be remembered that the power required by the tool is generally nearly the same at all speeds, so that the motor must be large enough to give the full power required at its lowest speed: a condition practically vetoing this system of control. However, it is a great convenience to be able to vary the speed of the motor within certain limits, as in this way additional steps to those allowed by the mechanical gear can be obtained, and as these are frequently rather large, a much nearer approximation to the best cutting speed of the tool can be obtained. This, of course, only applies to motors driving single machines, and it is not so important as to warrant the minute sub-division advocated by some engineers, who would instal separate motors of capacity as low as ½ or even ¼ H.P.

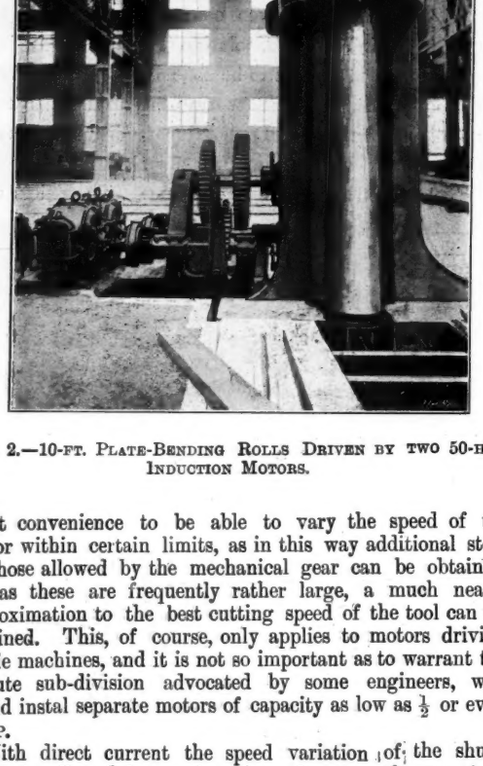


Fig. 2.—10-ft. Plate-Bending Rolls Driven by two 50-H.P. Induction Motors.

With direct current the speed variation of the shunt motor is effected by varying the voltage at the armature terminals, either by rheostat or by the use of a three-wire or multi-voltage system, or by varying the excitation. The three-wire is simpler than the multi-voltage system, and by using it and a field regulating rheostat, as much variation as is requisite can be obtained. But only in comparatively few cases is a wide range of speed variation essential.

Up till the time when the induction motor was introduced, very little was done in the way of power supply by alternating current. The induction motor, however, is about as simple as any machine could be. The induction motor is not adapted to running at variable speed, and is therefore used in conjunction with some type of mechanical gear for this purpose. The electrical gear for its operation is very simple indeed, comprising for the small sizes simply a switch with an auto-transformer, which is used at starting to avoid drawing too heavy a current from the line to supply the large starting torque. By adding slip rings to the secondary and arranging an adjustable resistance in series with it, the speed may be varied through wide limits; motors of this class have a very powerful starting torque, and are suitable for use on hoists, elevators, &c. A suitable crane motor with large starting torque is made, however, in the simple closed-secondary form.

The paramount advantage of this type of motor is its extreme simplicity of construction and operation, and, as a natural consequence, minimum cost for attention and repairs. It is the most hardy machine on the market; it will take 100 per cent. overload for short periods, and 50 per cent. for hours, and can even be pulled up dead without injury. After a shut-down of the generating plant, it is not necessary on re-starting to switch in all the motors separately, as they can all be left in circuit and started up with the generators; this is not possible with direct-current motors.

One of the most modern electrically operated plants is that of the steam engineering department of the Brooklyn Navy Yard. In this plant induction motors are used throughout, power being supplied by 400-kw. alternators in a separate power house.

A much larger plant has recently been installed in the great new works of the New York Shipbuilding Co., at Camden, N.J. Both alternating and direct current are here used, and power is supplied by two 500-kw. direct-connected Westinghouse double-current generators (a view of which appears in fig. 1) at 250 volts and a frequency of 25 cycles per second when making 120 revolutions per minute. A notable feature of these machines is that they automatically adjust themselves to the demand for alternating or direct current, the respective outputs, alternating or direct, being in proportion to the demands. The direct current is employed for lighting, for which purpose a large number of enclosed arc lamps are used, and for the crane motors, of which there are 35, ranging from 5 to 100 tons capacity, actuated by motors of 2,000 H.P. in the aggregate.

From the time when the material enters the works until it leaves them as part of the completed ship, it is handled entirely by electric cranes; no freight cars have to come into the shops, and the floor is therefore not cut up with tracks and run-ways. A large gantry crane of 88 ft. span, 22 ft. lift, is mainly used for handling and storing plates, and is equipped with lifting magnets which effect an enormous saving in labour. The two 10-ton trolleys are equipped with 25 H.P. street-car motors, which can lift the full load at 20 ft. per minute, and small 2-H.P. crane motors for traversing; the bridge is moved along the run-way by two 25-H.P. street-car motors, operated in series parallel. This gantry crane is largely used as a feeder for the other machines in the shops.

There is a 16 ft. boring mill built by the Niles Tool Works Co., operated by three induction motors of 3, 5 and 10 H.P. respectively. This machine takes 90 in. under the tools, permitting the bar to travel 48 in., and is fitted with three boring arms, two for use when the work is revolving, and one when it is stationary; the rim of the table runs in a groove cut in the bed and flooded with oil.

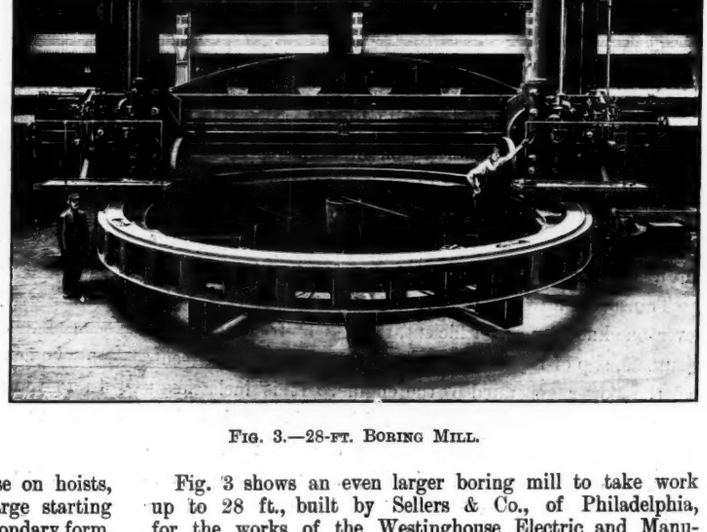


Fig. 3.—28-ft. Boring Mill.

Fig. 3 shows an even larger boring mill to take work up to 28 ft., built by Sellers & Co., of Philadelphia, for the works of the Westinghouse Electric and Manufacturing Co.; this machine, like all those in the illustrations, is actuated by induction motors. In fig. 2 is shown an equipment of plate-bending rolls, driven by two 50-H.P.

motors, which can handle boiler plates up to 10 ft. wide and 1½ in. thick. Fig. 4 illustrates one of the most interesting machines in the New York Shipbuilding Co.'s Works. It is a multiple-spindle boiler shell drill, which

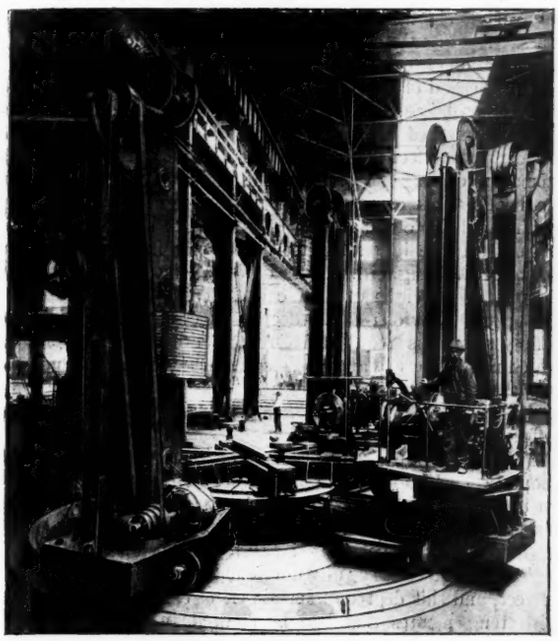


Fig. 4.—Multiple Spindle Boiler Shell Drill.

will handle boilers up to 20 ft. diameter and 20 ft. length. Each of the three columns carries a drill-head with three spindles, so that 12 holes may be drilled simultaneously. Fig. 5 shows a very compact and neat 10-spindle drill by Pratt & Whitney, of Hartford, U.S.A., and fig. 6 a 122-in. Sellers lathe in the Westinghouse Works at Pittsburg. Fig. 7 is interesting from the fact that it represents a type of tool which, without electrical power, would be almost impossible; such tools are moved about on the floor of the shop itself, and can be brought up to the work instead of the work being brought to them. The illustration represents a 25-ton portable tool at Pittsburg.

The entire electrical equipment referred to above was supplied by the Westinghouse Electrical and Manufacturing Co., of Pittsburg, U.S.A.

FLAME ANALYSES AND FUEL COMBUSTION.

By W. H. BOOTH, M.Am.Soc.C.E.

The vibration velocity of light, by which is meant those etheric waves which are capable of making their existence felt to our organs of vision, varies from nearly 400 billion oscillations per second to nearly 800 billions; that is to say, about one octave alone comes within the capacity of the eye to discern. The lower number corresponds with the extreme red of the spectrum, the higher frequency with the extreme violet. Beyond the extreme red is a long range of oscillations—rays invisible to the eye—which manifest themselves as heat. Beyond the extreme violet rays exist a long series of invisible rays known as actinic or chemical rays. These are the rays which are most energetic in producing chemical effects. They are the active rays in photography, and are those which produce sunburn and the like effect from exposure to electric light. As these ultra-violet rays produce chemical effects, so are they produced by chemical action. The more intense the act of chemical combination, as in the burning of carbon, the greater will be the actinism of the light produced. Very high temperatures produced by combustion approach a white colour the more closely as the temperature rises, and to some eyes—fatigued by too much observation of molten cast-iron—the clearance of the final hot slag gives a peculiar neutral light lavender colour indicative of the high temperature.

The proportion of rays of any particular colour in a furnace will indicate the intensity of the action which is going on within that furnace. It is extremely difficult for the most highly experienced eye to discern the full action of a furnace at high temperature—not, perhaps, so much because of inability to estimate the relative amounts of colour present, as because of the superabundance of heat rays which accompany the chemical rays, and generally the dazzling effect of even moderate temperatures.

The extreme brightness of the steel furnace has necessitated the use of violet-coloured glasses to enable the workmen to watch the progress of the melt without discomfort.

Engineers have not accepted as they ought to accept the teachings of physics as an aid to correct practice. Science and practice have been kept apart. The scientific man is apt to thank heaven when he makes a discovery that he believes cannot be put to the slightest possible good, and the man of practice gibes at his scientific brother, and they do not learn from each other. Moreover, the professional teacher, when he steps up or down into the arena of practical engineering, appears to leave behind him the scientific knowledge he has been teaching, and the practice of the quondam man of science partakes of the crudest efforts of the tyro. He appears to find a difficulty in applying his past teaching to his present practice, and not to have a sufficient fund of practical adaptability to conform his practice to his past teachings. In the combustion of fuel, this neglect of scientific teaching is almost universal. The man of science finds that the combustion of fuel, especially of bituminous coal, is carried out along extremely unscientific lines. He accepts these wrong lines and there is no case of any serious attempt on the part of any professedly scientific man to put the art of fuel combustion upon a sound basis. Accepting the crude appliances among which he descends, he is apt to conclude that the hydro-carbons of bituminous coals cannot be utilised, and hence the assertion is sometimes made that the hydrogens of bituminous coals cannot be

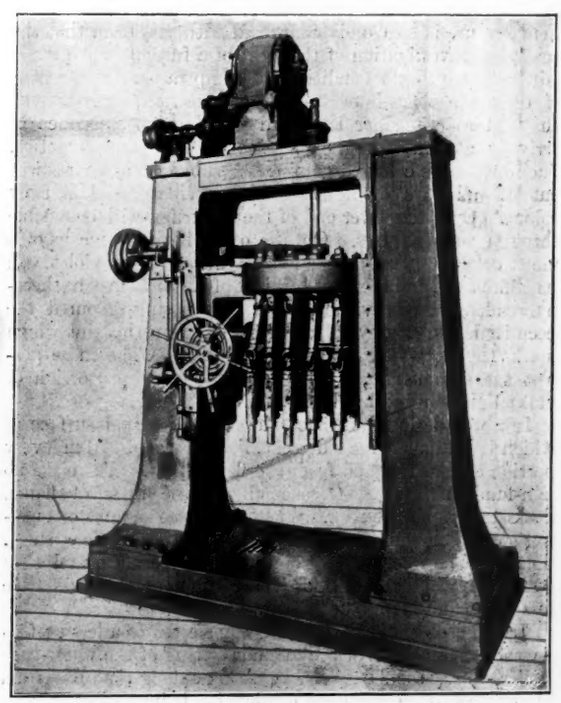


Fig. 5.—Ten-Spindle Drill.

counted upon as useful calorifically. The conclusion thus arrived at is probably erroneous, even on the basis upon which it is built.

Hydrogen ignites so very much more readily than carbon and at so low a temperature, that the probability is the

hydrogens do burn, and in doing so, they snatch the available oxygen from the surrounding air and deprive the nascent carbon of any opportunity of combustion, causing it to deposit as soot. Unless there is sufficient temperature,

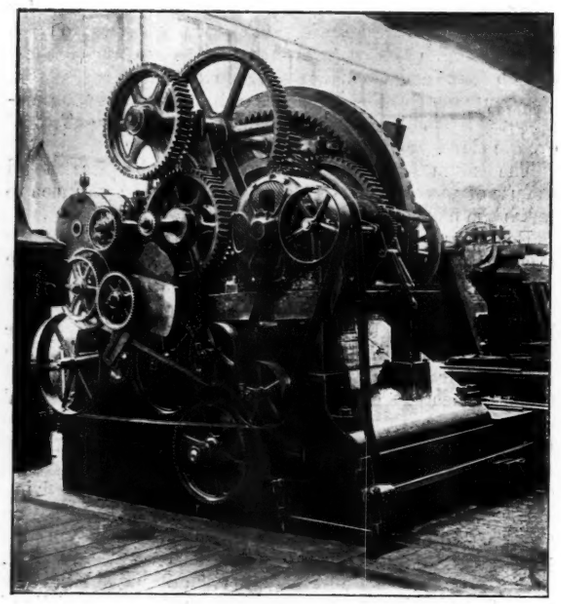


Fig. 6.—122-in. Lathe.

there is no hope of burning bituminous coal, as it very easily can be burned, without the formation of smoke. This is, perhaps, too crude a method of expressing the needs of the case, but, when the most important industrial operations are absolutely neglected by our supposed teachers and leaders of scientific practice, it devolves upon those to whom science is less familiar, but more attractive, to step into the breach. Temperature is so closely connected with actinism, that the analytical investigation of the light of a furnace will give a fair insight into its conditions of temperature. By means of transparent media of suitable composition, light may be analysed in a manner that will afford great assistance in arriving at sound engineering conclusions and practice. Such media are coloured glasses. A ruby coloured glass will cut off all rays of light of higher vibration than ruby colour. Only the lower end of the spectrum will be visible through such a glass. On the other hand, by means of a violet coloured glass, all the less active rays than violet will be eliminated, and the most brilliant of furnaces may be thereby rendered easily visible, its interior being coloured the peculiar lavender grey colour, or approaching this tint which marks the ultra-violet end of the spectrum. The more perfect the combustion, the larger will be the proportion of violet light emitted by the flames.

In a well-designed furnace, the whole internal surface of which is brilliantly incandescent, light proceeds from every portion of the area and from the flame itself. There are no non-luminous areas. Occasionally in the mass of flame, dark streaks may be seen. These represent streams of burning gas which while incandescent, are below the violet stage. They may be traced to a point of disappearance, and they would probably radiate light if the colour of the glass were less violet and more blue.

Let the observation be now transferred to a less perfect furnace such as that of the common setting of the water-tube boiler, where the flames rise vertically among the tubes from the grate surface, and good combustion is impossible. With the unprotected eye the flames will appear to be giving light all the way from the fire surface to between the tubes. Combustion appears fair. If, however, these light-giving flames be examined by the aid of the violet glass, they will be cut down to short tongues of flame projecting but little above the fire surface. Even these tongues of flame give forth little illumination. Above the flame the gases appear to be simply dark dun-coloured streams of gas, soot laden and murky. The violet glass or analyser has cut out all the rays of small actinic power and low temperature, with the result that the only remaining light rays are those immediately above the furnace.

The effect of radiation is to cool the flames below the range of violet long before they have risen to the level of the tubes. Apparently there is nothing but radiation to explain the reduction of temperature.

This method of analysis of the products of a fire is useful, not merely because it enables a furnace interior to be visually examined with ease and comfort, but because it shows so clearly the effect of good design, and the bad influence of premature cooling. It affords most conclusive testimony to the benefits that accrue from proper design, and should be an effectual silencer of those who argue that smoke is one of the unfortunate inevitables of combustion in place of being but a proof of ignorant and careless design and neglect of the plainer principles of chemical science.

The use of violet-coloured glass is essential. It is not simply that it is requisite to reduce the amount of light which meets the eye and renders vision impossible. Such a result could be attained by means of glass otherwise coloured, as by smoke, so that it is less transparent, but still not diffusive as is ground glass.

Violet glass is necessary because of its specially analytical properties. I am not prepared to say that perfect combustion cannot occur at temperatures below those which are associated with light rays that can traverse violet glass. It is, however, very probably true that the violet degree of actinism must be very fully developed if combustion is to be perfect, and this degree of actinic effect cannot be associated with temperatures that can be secured in any furnace so arranged that the gases rise vertically from the grate surface to pass between water pipes before they have been thoroughly commingled and burned in a free space. Thus the ordinary arrangement of water-tube boiler is absolutely hopeless and impossible. A single inspection of such a furnace through the analyser will effectually convert any open mind and point the necessity for better practice.

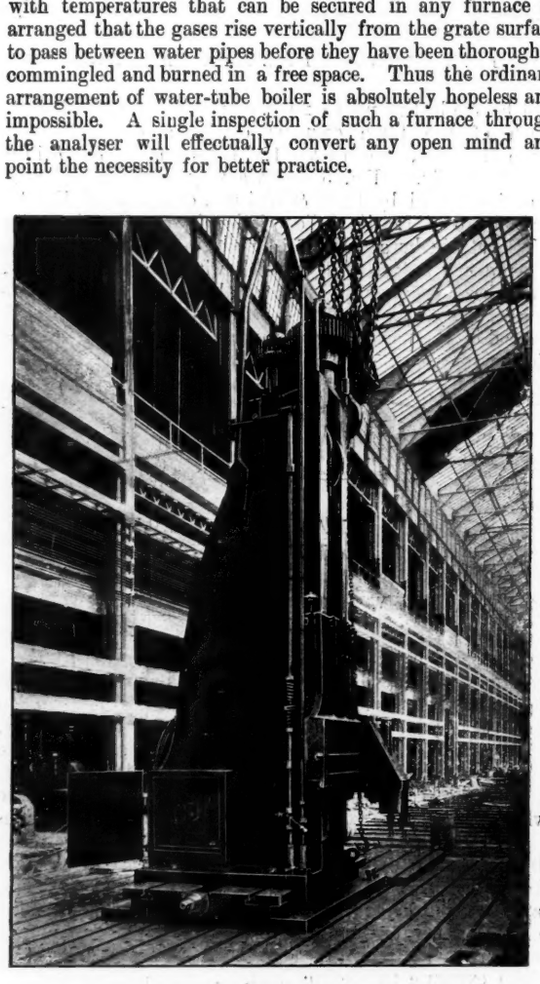


Fig. 7.—Portable Drilling Machine.

Much has been heard of late of the hardships of electrical engineers and the manner in which their special province has been invaded from outside. The arguments of the other

side are, of course, that in their steam engineering work no set of men has ever exhibited the same callous indifference to good practice and to scientific facts and teachings as have the electrical engineers.

There is, I believe, not more than one electrical station within six miles of Charing Cross wherein the slightest appreciation of the necessary chemistry of combustion can be found embodied in the steam generating plant. Yet we are asked to treat electrical engineering as a close profession, the votaries of which bring discredit on themselves, and reflect it upon steam engineering by their intermeddling in the profession of steam engineering. If they would intermeddle in a scientific manner there is no steam engineer would object, but at the beginning of a fresh century it is lamentable to find steam-raising put back to the dark ages, and the methods of the untutored savage applied to so refined a chemical process as the combustion of hydro-carbon compounds.

CONTRACTS OPEN.

(*Continued from page* 20.)

Stalybridge.—January 5th. Cables, telephone and test wires, high and low pressure switchboards for main and sub-stations. See "Official Notices" December 12th.

Stepney.—January 15th. 500-KW. steam dynamo. See "Official Notices" December 19th.

Stockport.—January 24th. 645 tons of grooved steel tram rails, 15 tons tie bars, also special work. See "Official Notices" to-day.

Stoke-upon-Trent. — January 14th. Destructor, boilers, pumps, conveyor, economiser, steam dynamos, balancer, boosters, switchboard, battery, mains, &c., crane, and workshop machinery. See "Official Notices" December 12th.

Sunderland.—January 2nd. Lancashire boiler, with fittings, &c. See "Official Notices" December 5th.

Swansea.—January 8th. Wiring and fittings for new harbour offices. See "Official Notices" December 19th.

Wallasey.—January 15th. Steam dynamo, Lancashire boiler, condensing plant and cooling tower. See "Official Notices" December 5th.

Wellington, N.Z.—January 21st. Supply and installation of all material, including power house equipment, overhead work, track work, feeders, tramcars, &c., for tramways. See "Official Notices" December 12th.

CLOSED.

Belfast.—The Gas and Electric Committee has accepted the tenders of Messrs. Bruce Peebles and Messrs. Handley and Shanks, for the supply of motors.

Messrs. Fabius Henrion are supplying cored and solid carbons to the Corporation for the street arc lighting.

Belliss Engines.—The Sunderland Forge Co. has ordered two 172-B H.P. engines by Belliss & Morcom, Ltd., for Finchley; Messrs. Mather & Platt have ordered one 495-B H P. engine from the same firm for Chester; and a third sub-contract placed with Messrs. Belliss is for one 290-B.H.P. engine for Chesterfield. Messrs. Dick, Kerr & Co. have let the sub-contract for one 1,000-H.P. engine for Croydon to Messrs. Belliss & Morcom, Ltd. The Smithfield Markets Electric Supply Co. have placed a contract for one 450-H.P. engine, coupled direct to an E.C.C. dynamo, with the same firm.

Croydon.—The Corporation has resolved that the tender of Messrs. Dick, Kerr & Co. be accepted for an engine and generator at the price of £5,630; of Messrs. Mirrlees, Watson & Co., Ltd., for condensing plant at £2,305, and that a cooling tower be erected in substitution for the present cooling pond at £640.

Dewsbury.—The tender of Messrs. Dick, Kerr & Co. has been accepted by the Corporation for an engine and dynamo required for the supply of energy to the B.E.T. Co. The tenders submitted numbered 200.

Dungannon.—The U.D.C. has accepted the tender of the Westinghouse Co. to supply engines, producers, and other plant for the lighting scheme of the town at £2,033.

Falkirk.—Messrs. Thomson & Co., of Falkirk, have received the contract from the Town Council for the wiring of the Town Hall and the Burgh buildings.

Gravesend.—The T.C. has accepted the tender of Veritys, Ltd., for the supply of electric light fittings for the Town Hall, magistrates' room, and offices.

Great Northern Railway.—The contract for low voltage incandescent lamps for the Great Northern Railway Co. has been placed with Mackey's Electric Lamp Co.

Leith.—Messrs. Fabius Henrion, of Nancy, have secured the contract for the supply of arc lamp carbons for the municipality as follows:—

Cored, 18 mm. × 8 in., per 1,000	£1 17 10
Solid, 12 mm. × 8 in., per 1,000	0 17 0½
Cored, 18 mm. × 12 in., per 1,000	2 16 10
Solid, 12 mm. × 12 in., per 1,000	1 5 7

Newcastle-on-Tyne.—The Tramways Committee has decided to put down a Willans high-speed engine of 850-H P. for direct coupling to a Bruce Peebles dynamo for supplying power to the tramways.

Newark.—Messrs. Simpson & Co. have decided to put down another 250-H.P. Willans engine for direct coupling to a Westinghouse dynamo for supplying power to their works.

Surbiton.—The U.D.C. has accepted the tender of Messrs. Gaze & Son, of Kingston-on-Thames, for the erection of the electric light station at £4,539.

FORTHCOMING EVENTS.

Friday, January 2nd.—At 8 p.m. Institution of Junior Engineers. Westminster Palace Hotel. Paper on "Modern Marine Boilers: a Consideration of the Relative Values of Different Types," by H. M. Rounthwaite, M.I.M E., honorary member.

Saturday, January 3rd.—At 3 p m. Royal Institution. Lecture IV. by Prof. H. S. Hele-Shaw, "On Locomotion: On the Earth—Through the Water—In the Air." (Also on 6th and 8th inst.)

Wednesday, January 7th.—At 8 p.m. Association of Engineers-in-Charge, St. Bride Foundation Institute. Paper on "Smoke Prevention," by W. H. Booth.

Thursday, January 8th.—At 8 p m. Civil and Mechanical Engineers' Society. Meeting at Caxton Hall. Paper by A. Marshall-Arter on "Indicating High Speed Engines."

At 8 p.m. Institution of Electrical Engineers. "Notes on Recent Electrical Design," by W. B. Esson; "Notes on the Manufacture of Large Dynamos and Alternators," by E. K. Scott.

Saturday, January 10th.—At 2.30 p.m. Northern Section of the National Electrical Contractors' Association. Annual general meeting at the County Hotel, Newcastle.

Tuesday, January 13th.—At 8 p m. Institution of Civil Engineers. Paper on "Electric Automobiles," by H. F. Joel, Assoc.M.Inst.C.E.

Friday, January 16th.—At 8 p.m. Institution of Civil Engineers. Students' Meeting. Fifth annual lecture by Prof. W. C. Unwin. Subject:—"The Measurement of Water."

Saturday, January 17th.—At 3 p.m. Institution of Junior Engineers; visit to new electricity works of Shoreditch Borough Council, at Whiston Street, Haggerston.

NOTES.

British Commercial Agents Abroad.—The *Times* says that the Secretary of State for Foreign Affairs has arranged with the Lords Commissioners of the Treasury for the extension of the appointments of the British Commercial Agents in Russia, Switzerland, the United States, and Central America for a further period of three years from 1st inst. The names and addresses of the agents are as follows.—Mr. H. A. Cooke, 17, Malaia, Dimitrovka, Moscow; Mr. J. C. Milligan, British Consulate-General, Zurich; Mr. E. Seymour Bell, 196, La Salle Street, Chicago; Mr. F. W. Melville, care of British Legation, Guatemala. The Secretary of State has also appointed Mr. E. S. Schwabe to be British Commercial Agent at Vladivostok for an experimental period of two years. The business of the agents consists in watching and reporting on the commerce, industries, and products of special districts, and in answering inquiries on commercial subjects. In cases requiring a journey the agent will report to His Majesty's Ambassador or Minister, who will decide whether an offer should be made to procure the information. If journeys are undertaken by the Commercial Agent, a subsistence fee of £1 1s. per night will be charged, in addition to the actual expenses of locomotion, and payment in advance will be required.

An X-Ray Lawyer.—In consequence of attempts at fraud in connection with claims for alleged damage due to X-ray surgery and electrical accidents, the Law Department of Chicago has appointed Dr. H. Preston Pratt to the office of "X-Ray Expert and Electrical Diagnostician."

Mr. Swinburne v. the Text-Books.—We received from Prof. John Perry, too late for insertion in our last issue, a copy of a letter addressed by him to the *Engineer*, which we reproduce below:—

"Sir,—The writings and speeches of Mr. Swinburne are so numerous and clever and original and altogether interesting that the fear of seeming ungrateful restrains such scientific men as read them from pointing out how he is misleading students. There are several misleading general statements in his I.E.E. address, and one is of such importance that I am compelled to refer to it. In the treatises maligned by him, $d\mathrm{H}$ is the heat entering a quantity of stuff which is at the absolute temperature θ and pressure p and volume v. If $d\mathrm{H}/\theta$ be called $d\mathrm{Q}$, then Q is a property of the stuff which returns to its old value when θ and p and v return to their old values after any changes. This is the second law of thermo-dynamics.

"Now, Sir, you know that I am only stating here what is in all the books, and Mr. Swinburne says that all engineering text-books and nine out of ten treatises on mathematical physics are wrong in such statements. How are they wrong? Does he mean that there is no truth in the second law of thermo-dynamics? If his words have any meaning at all, they surely mean this, and indeed they may also be gathered not merely from what he says about entropy but everything that he says on the subject of thermo-dynamics. Of course, when Mr. Swinburne gravely informs an audience that two and three do not make five, but something else, everybody takes him to be joking, but when he tries to upset some other well-established scientific principles, if these principles are not sufficiently well fixed in the minds of his hearers, he may do much harm whether he is or is not in a joking humour. For my part I believe that it is never much of a joke, but there is evidence of sardonic humour in saying what one pleases, wrong or right, before a believing audience. I feel very sorrowful when I see such great talents, such a wonderful personality wastefully employed. It is only one more example of Englishmen's contempt for science.

"The idea of calculating directly from the entropy which is as inherent a property of a body as its volume or pressure or temperature, has, I think, greatly simplified all the theory of heat engines; it saves modern students from the hundred vague misleading notions which tormented the students of a past generation. If Mr. Swinburne does not believe in its usefulness, I feel quite sure that he does not know what he is talking about.

"I wonder if the students will understand me better if I put the matter this way:—

"A pound of air at 32° F. and atmospheric pressure being said to have no energy or entropy.

"A pound of air of volume 3 cub. ft. and temperature 1,129° F. the entropy 0·00415 (I usually call this 0·00415 Ranks); it also has the pressure 15,950 lb. per sq. ft., or about 7½ atmospheres. We, the writers of engineering text-books and the writers of all except one-tenth of the books on mathematical physics (according to Mr. Swinburne) say that if this pound of air goes through any changes of volume and temperature whatsoever, and if it comes back to the same 3 cubic feet in volume and 1,129° F., it will have the old pressure and the old entropy.

"Or again. A pound of water stuff is at 365·7° F., and if it is 90 per cent. dry steam and 10 per cent. water, it has an amount of entropy which I call 1·456 Ranks (counting from water at 32° F. and atmospheric pressure). We affirm that this pound of water stuff may undergo all sorts of changes, but if it is brought back to this state again, its entropy will be exactly 1·456 Ranks.

"His words say that Mr. Swinburne desires our right to make these statements, they deny the truth of the second law of Thermo-dynamics.

"JOHN PERRY.

"Royal College of Science, S.W."

Prof. Perry writes more in sorrow than in anger, but we have grave doubts whether Mr. Swinburne's heart will be melted by the professor's lament over his heterodoxy; certainly he is not likely to be converted by "arguments" of the *tu-quoque* order. It happens that the statements and mode of treatment attacked by Mr. Swinburne in his Address are embodied in Prof. Perry's own text-books—excellent and practical works indeed, but not necessarily infallible. It is a curious and regrettable sequel to Mr. Swinburne's appeal for greater cordiality and a better understanding between scientists and practical engineers that one of the most practical of our scientists should thus attack one of the most scientific—if not the most—of our practical engineers. To accuse Mr. Swinburne of contempt for science is at least as unjust as it would be to impeach Prof. Perry's views on practical engineering. What the President objected to was the *misuse* of the idea of entropy, and he did not deny its usefulness at all—quite the contrary.

An Unfortunate Dam.—The *Canadian Electrical News* says:—"A newspaper dispatch of November 30th conveyed the information that a portion of the dam of the Chambly Manufacturing Co., at Chambly, Quebec, had on that day been carried away. It is understood to be the intention to build a new coffer-dam, which will probably be completed within a month. Since its inauguration, less than five years ago, this plant has been particularly unfortunate. This is the second time that the dam has broken away; the original water-wheels have been replaced by others of different type; the generators have been rewound, and material changes have been made in the switchboard. In the construction of the plant engineering advice of a high standard was secured, but notwithstanding this and other precautions, the changes to which we refer were found advisable. These circumstances indicate that, as a rule, water-power is not as reliable as steam."

Fatality at Willesden.—An inquest was held last Friday into the cause of death of Wm. Ayling, who, according to report, was dragged into the ash-handling machinery at the Metropolitan Electric Supply Co's. Willesden works on December 22nd. The evidence given included a statement by Charles Capp, who was employed as ash shifter, and worked in the subway where the accident happened. It seems that Ayling was up a ladder, leaning over a shaft that ran along near the top of the arch, oiling. Capp asked deceased to come down to enable him to get by with a skip of ashes. He did so, and climbed up again directly the skip passed, and shouted out, "Oh!" three times. Witness saw that he was caught in the machinery and tried to catch hold of him, but he was drawn up out of reach. Another workman ran off to stop the engine, and witness shouted up through an opening to the driver. The machinery stopped almost immediately, as "a sort of chuck" was removed as well as the driver stopping the engine.

From other evidence it seems that the man's arm was drawn round the shaft by a coupling, and his head was bleeding and lying just over the flanges of the coupling. He was drawn up between the coupling and the hanger; it was believed that he was drawn up through his sleeve being caught by the nuts in the coupling. The shaft revolved 22 times per minute.

A juryman who had viewed the scene, said the tunnel was well lighted, and the machinery was 9 or 10 ft. from the ground. Medical evidence was given to the effect that death was due to a fracture of the skull.

The jury found that "Deceased met his death through a fracture of the skull, accidentally, but accelerated by the unprotected state of the machinery, and we stringently recommend that the machinery should be protected in accordance with the Factory Acts."

Lectures.—Under the auspices of the Corporation of Glasgow, Mr. W. A. Chamen, electrical engineer for the city, recently delivered a lecture on the electricity supply of the Corporation. Ex-Bailie Maclay presided. The lecturer gave a description of the electricity works of the city, and illustrated the various uses to which electricity could be put. Referring to the supply of electricity by the Corporation, he said that during the month of December 15,000 H.P. was actually used to carry on the supply, to which was to be added another 2,000 H.P., borrowed from the surplus power of the tramways department. The growth of the electricity department seemed to know no bounds, and it was clear that by next winter between 2,000 and 3,000 H.P. more of plant would be required to meet the increased demand. The electric motors connected amounted in the aggregate to about 4,000 H.P. It was confidently hoped that the addition of large numbers of motors for industrial purposes, which would be in use summer and winter, would tend to cheapen the general cost of production. At the close the lecturer was awarded a hearty vote of thanks.

On December 18th at the Dundee Institute of Engineers, Mr. David Maxwell delivered a lecture on "Some Applications and Advantages of Electric Motors."

Electricity in Coal Mines.—The Parliamentary Committee recently appointed to report on this subject held its third sitting on Wednesday, December 17th, when evidence was given by Mr. H. Davis, of Davis & Son, Derby.

It is stated that the Hulton Colliery Co. are opening two new collieries near Atherton Station, on the Lancashire and Yorkshire Railway, and are introducing some important developments with regard to the introduction of electricity. The mines are 500 yards deep. Electrical machinery for coal-cutting and ventilation purposes is being introduced; an electric lighting installation is being put down, and electricity will also be used for haulage and screening purposes; whilst another important innovation to be tried is the substitution of hydraulic cartridges for forcing the coal down instead of blasting.

Burning Coal Dust.—A method of burning coal dust is described in *Mines and Minerals*. The coal is first dried down to 2 per cent. moisture and ground fine to pass a sieve of 80 mesh. In this condition it is fed from a hopper by a special conveyor into an air blast pipe fed by a fan with air sufficient to burn the dust. The coal falls in front of an air nozzle by which it is well mixed in the air current, and the whole is again mixed with air from a second nozzle near the furnace entry; the mixture enters the furnace in an upward sloping direction and strikes against a brick arching. The arrangement is shown applied to an underfired boiler, and is claimed to reduce fuel consumption by 25 per cent. with no formation of cinder and very little ash, but nothing is said as to the emission of dust at the chimney top, a probability that calls for the use of a settling chamber. There is no change made in the furnace, the ordinary bars being left in, and therefore, we may suppose, still admitting some air, or surely they would be melted. Dust fuel is closely akin to atomised oil, and should be capable of efficient and perfect combustion if only the dust difficulty can be got over.

Shock Fatalities.—Mr. C. L. Drew, Coroner for the Western District, opened an inquest on Saturday last on the bodies of William Arthur Line, 35, caretaker, and William Brown, 23, mechanical engineer, who met their deaths in the Fulham Baths on the previous Tuesday evening.

E. A. Chivers, bath attendant, stated that Line went into cubicle No. 8. After a short time he heard a scream, and going to the cubicle, found Line with his hands on the top of the partition. He tried to pull the man down, but could not do so, and at once ran and switched off the electric current. Then he went back and saw the man lying in the bath, and tried to turn him over. Other assistance was at hand, and then he went off to examine the other cubicles. He could not open No. 4, but forced it open, and then saw the deceased Brown lying on the ground. He believed that at that time he was dead. Probably an hour elapsed before he left Line and found Brown. Brown, when he found him, was lying at the bottom of his cubicle naked; he had had a bath at the time. Several of the bathers stated that they had felt shocks. That was an occasional occurrence. He nearly always warned bathers not to get up and put their hands on the partition, but, if they wanted anything, to call out. The partitions were made of glazed slate in galvanised iron framework.

L. Jones, another bath attendant, gave corroborative evidence. The deceased was hanging by both hands; he said, "Take me down." He helped to lay the man on his back in the bath. This was only done after the electric current was switched off, when his hands were released, and he fell downwards. Witness guided his fall. He had frequently put his hands on the top of the partition when his hands were dry, without feeling any shock, although the current was on. The cry he heard was of a man in agony.

Mr. A. A. Baker, superintendent of the Baths, said that, on being called at 10 minutes past seven on the evening named, he went to No. 8 bath, and saw Line reclining in an empty bath, assisted by one of the attendants. He had him lifted out, and directed the method recommended for recovering consciousness. He heard someone say that deceased had had a shock, and he at once put his hand on the top of the partition, but felt nothing. Then he put his hand on the cast-iron capping, and got a shock. Three-quarters of an hour probably elapsed before Brown was discovered. He was lying on his face on the ground, and he thought, by the state of the water, that the man had had his bath. He had never had complaints of electric shocks before. The iron caps were used to keep the framework in position. The fuses were all in order, and remained so after the accident.

L. Debetoine, manufacturer, a bather at the time of the occurence, was drying himself when he heard a shriek. He got up on the edge of his bath, and put his left hand on the partition to look over, when he received a shock, which knocked him back into his bath.

Another bather put both hands on the partition to look over, when he received a shock, and fell back into the bath.

Dr. Morris J. Williams gave evidence, first as to the case of Line. He found the man dead, but recommended the attendant to continue his efforts to restore animation. He went away, but was recalled to see the body of Brown; *rigor mortis* had set in, and he considered that death had taken place an hour. He made a post mortem examination of each body. In the case of Line he was of opinion that death had resulted from a strong stimulus—a shock, in fact. The stomach contained about 2 lbs. of food, and that would tend to weaken the action of the heart. A very small shock would have been sufficient to bring on syncope and death. By holding on with both hands the current would have been more readily directed to the heart. The top of the partition was made of galvanised iron, which was a strong conductor, and the wires were cased in steel tubing, which was also a conductor. A strength of six volts was as much as one could bear, and in a recent case a shock of 96 volts caused death. The supply at the baths was 200 volts in the cases before the coroner. In the second case the body was well nourished and all the organs were normal. The death in the second case was due to an electric shock.

The coroner stated that as an inspector from the Board of Trade must be in attendance before the inquiry closed, he would adjourn the Court until Saturday next (to-morrow).

"The American Invasion."—With reference to the speech of Mr. George Westinghouse, delivered at the meeting of the British Westinghouse Co., and printed at some length in our "City Notes" on December 19th, 1902, Messrs. Crossley Bros. write to *Engineering* as follows:—

"At a time when everything emanating from an American source, whether statements or machinery, is implicitly believed in by a certain section of the British public, who are only too eager to accept them as signs of British deterioration, we should like to point out one or two fallacies in the speech of the chairman of the British Westinghouse Co. at their recent third annual meeting, which have been widely circulated through the Press. As 'British manufacturers,' we protest against the bombastic assertion that the new American works at Old Trafford will 'prove an object-lesson to other British manufacturers.' Time alone will show, but at the present moment we cannot own to any fears on this point. It is possible that the American invader may have quite as much to learn as to teach. Then, again, as regards the remarks on gas engines: One would suppose that they were hitherto unknown in this country, until kindly introduced by the foreigner. Possibly he has yet to learn that they have been made in thousands in this obsolete and played-out country for the last 30 years. The very wording of the report displays ignorance. It is stated that gas engines 'would prove the most important instrument for the cheap production of power.' Why, they *have* proved it, and this for years past. As for the qualification 'if a simple and effective device be found to remove tar and dust from ordinary soft-coal producer gas," this again shows want of knowledge of the progress made in this country. It is an indisputable fact that this 'consummation devoutly to be wished' has been achieved years ago by some of our out-of-date engineers. If the American invader is only in a position to state that 'such device would soon be available to the company, it only shows that already he has, to use one of his own countrymen's phrases, 'taken a back seat.' The whole question of large gas engines 'operated with gas made from anthracite coal or coke which has been cleaned sufficiently,' has been thoroughly thrashed out, and made an established success, by Mr. Dowson and ourselves, more than 20 years ago, and can be seen not only at our own works, but all over the country. We have used it for 20 years as our absolute source of supply, and frequently fires have not been out in the generators for two years, thus showing the very small amount of repairs necessary. One story reads very well until we hear the other side, and it is only those who are unaware of the progress that has been made in this country with large gas engines and producer plants during the last 20 years, who can believe that the western hemisphere can teach the eastern anything in this connection."

The North-Eastern Railway's Motor-Car Project.—According to the *Mechanical Engineer*, the two auto-cars which are being built at York to run on the North-Eastern Railway between the Hartlepool and West Hartlepool stations will have a speed of 30 miles an hour. The cars will be 53 ft. long, and will provide seating accommodation for 52 passengers. At one end of the car there will be a Napier petrol engine of 85 B.H.P., with four cylinders; the engine will drive a dynamo generating electricity for two motors, which will be fixed on the bogie underneath the engine compartment. The body of the car will be much larger than that of the ordinary carriage, approximating closely to the tram type; in fact, the car will be a tramway saloon, with an engine compartment at one end and a conductor's compartment at the other. The car will be fitted with electric brakes, and illuminated by electric light. The cars, it is expected, will be ready for commencing the service early in the new year.

Obituary.—We regret to have to record the death, which took place at his residence in Snaresbrook, of Mr. Thomas G. Lloyd, the secretary of the India-Rubber, Gutta-Percha and Telegraph Works Co. Mr. Lloyd was in his 62nd year, and had been connected with the Silvertown works for over 40 years. This long service, and the position he held at his decease, are ample testimony of the regard and esteem in which he was held by those with whom he was associated. Many of us in the electrical industry have had the opportunity of appreciating the quiet business-like courtesy that Mr. Lloyd invariably showed to those with whom he had dealings, and we feel that the Silvertown Co. have lost a valuable officer. We are informed that Mr. Lloyd, whose health had never been robust, succumbed through heart failure, following an attack of influenza. The funeral took place on Saturday, 27th ult., at Wanstead Old Parish Church, and was attended by such of his friends and associates as the Christmas vacation permitted to receive notice of his death. We sympathise with his widow and family in their loss.

The death has occurred at New York of Mr. Edward Douglas Jones, a partner of the late Cyrus W. Field, who laid the first Atlantic cable. He was 77 years of age, and retired from the engineering profession in 1885.

The Electrolytic Rectifier.—It is well known that if an alternating current is sent through an electrolytic cell having a carbon and an aluminium electrode immersed in a solution of alum, the current in one direction is almost completely stopped, while it passes freely in the opposite direction. It is when the aluminium is the anode that the current is stopped, and from this it appears that, under these circumstances, some film is formed on the surface of the aluminium plate which prevents the negative ions from reaching the metal. It is generally believed that the obstruction is due to a film of aluminium oxide formed on the surface of the plate, but Mr. K. E. Guthe (*Phy. Rev.*, December, 1902) urges that this view is untenable, and gives good reasons for the hypothesis that the resistance to the passage of the negative ions is due to the formation of a gaseous layer of oxygen, which becomes entangled in the partial layer of oxide on the surface of the aluminium plate. He shows that a layer of hydrogen is not entangled in this way, and therefore it opposes no resistance to the ions when the aluminium plate is a cathode. A rise of temperature was found to reduce the resistance of the film of oxygen, as might be expected from theory. The composition of the electrolyte did not affect the result as long as the negative ion was oxygen, but when an electrolyte with chlorine as negative ion was used the cell lost its rectifying property. He (Guthe) also replaced the aluminium electrode by a semi-permeable membrane of copper ferrocyanide, and found that the results corresponded closely with those obtained with the aluminium cell. It appears to follow from Guthe's experiments that the condition for the formation of an electrolytic rectifier is an electrode with a surface which will retain one of the gaseous films produced by electrolysis.

Electric Fittings.—The Electric and General Stores Co., of Sunderland, will show a representative collection of their patterns of electric light fittings at 44, Leazes Park Road, Newcastle-on-Tyne, from January 5th to 19th. A fittings catalogue is in preparation.

The I.E.E. Visit to Italy.—Mr. W. G. McMillan, the Institution secretary, has placed in circulation printed particulars of the preliminary arrangements which have been made for the visit to Northern Italy in April next. The party will leave London on Thursday, April 2nd, and, travelling *vid* Dover-Calais or Folkestone-Boulogne, Lucerne, and the St. Gothard, will arrive at Como on Friday, April 3rd. An advance party will, if practicable, be made up to start on Wednesday, April 1st, travelling by the same route, and arriving on April 3rd, but staying a night in Basle on the way. According to present arrangements, the programme will, in outline, be as follows, but it is necessarily subject to alteration:—

Saturday, April 4th.—Visit to the Valtellina electric railway and power house at Morbegno.

Sunday, April 5th.—No special arrangements will be made for this day, but an opportunity will be given to those who wish to do so to visit the tomb of Volta, about two or three miles from Como.

Monday, April 6th.—Leave Como for Milan, travelling *vid* Varese and the Milan-Varese Electric Railway, a visit being paid to the works of Messrs. Tosi, at Legnano, in passing.

Tuesday, April 7th.—Visit to the Paderno power house.

Wednesday, April 8th.—Visits to the works of Messrs. Pirelli and of Messrs. Riva Monneret, to the technical High School, and to generating stations in Milan. It is hoped that admission may be allowed to some of the numerous electrically-driven factories in Milan.

Thursday, April 9th.—Visits to the power houses at Vizzola and Tornavento.

Those members who expect to be able to join the party, should fill in the application form, and send it to Mr. McMillan as soon as possible so as to assist the Council in making arrangements.

Snow on Tram Tracks.—A problem of most vital interest to street railway companies, more especially in America, at this season of the year, is that of the removal of snow from the tracks, and in this connection the paper and discussion on this subject at the last meeting of the New England Street Railway Club brought out a number of points which seemed worthy of special note, particularly at the present time. It was tolerably well established, says the *Street Railway Journal*, that no single type of electrically-driven snow-plough is adequate to meet all classes of storms and service. For suburban or interurban lines, subject to heavy drifts in severe storms, there seems to be at present little apparatus on the market that can rival a powerful double-truck rotary, equipped with from 150 H.P to 200 H.P. in propelling motors, and with about 75 H.P. in motors geared to drive its fans. Such a plough would weigh about 20 tons, exclusive of its electrical equipment, and it should be liberally supplied with emergency jacks, lanterns, ice chisels, sand, salt, and shovels, which, when needed, are wanted badly. For light storms and general city service, some form of nose or radial plough is desirable, and this likewise should be equipped with emergency tools, and should have from 75 H.P to 100 H.P. in driving motors if of the single-truck variety. In all classes of ploughs the motors should be geared for good acceleration rather than for high maximum speed, although for suburban service a plough should be capable of getting out of the way of regular cars on clear track, which means a maximum speed of 15 to 20 miles per hour in most cases at least. The necessity of the personal interest of the operating superintendent in securing enthusiastic, persevering work from the men behind the ploughs and shovels was strongly emphasised. The company which cares for the physical comfort of its men is far from being a loser in the end, and proper shelter, food and hot drinks have been found to be no mean aids to the snow brigade in its successful campaigns against the storms. The assignment of various sections of the company's territory to the different foremen in the same manner that a fire department chief divides his city among his district captains was also commended. Another point brought out was the wisdom of cutting down the service by running fewer cars on roads where the power supply is inadequate to operate both regular service and ploughs. If the ploughs are to keep the road open for traffic they must in no case fall short of power, and must do effective work in the earlier stages of the storm, being given right of way as far as possible and kept moving.

Personal.—On Friday evening last a farewell dance was given by Mr. W. Murray Morrison, resident engineer and manager for the British Aluminium Co., to the employés at Foyers, to the Foyers estate tenantry, and to other inhabitants of Stratherrick. There were about 300 persons present. Mr. Morrison was presented with a gold chronograph subscribed for by the employés of the company as a mark of appreciation and respect. Mr. Morrison has been seven years at Foyers. He retains his connection with the company, but in another position.

Mr. W E. Langdon, electrical engineer to the Midland Railway Co., has this week retired from active service under the age limit. He had been in the service of the Midland Railway Co. since 1878, It will be remembered that he preceded Mr. Swinburne as president of the I.E.E. Mr. Langdon for years has been an occasional contributor to the REVIEW, and we wish him all that he could wish himself in his well-earned retirement.

On Wednesday last week the electrical staff and other officials of the Manx Electrical Railway Co. gave a farewell dinner to Mr. E. Christian, the late assistant electrical engineer to the company, who recently obtained an appointment as inspector of rolling stock on the newly electrified line of the Mersey Railway Co. Mr. Harold Brown, general manager of the Manx Co., presided.

Mr. Geo. Boorman announces that he has severed his connection with the firm of Cardwell, Boorman Ford-Lloyd, Ltd., and now represents the Davis Electric Lamp Co., of Moor Street, Cambridge Circus, W.C.

Magnetic Insulator.—A correspondent sends us a cutting from a recent issue of *Answers* reproduced below, which admirably illustrates the dangerous character of a very little knowledge:—"There is so much electric machinery used nowadays in ordinary life that watches, unless specially made to resist magnetisation, frequently get magnetised. Their case is then practically hopeless. This danger may also be avoided by the use of an india-rubber case, india-rubber being a perfect insulator."

Royal Institution.—Yesterday afternoon Prof. H. S. Hele-Shaw delivered Lecture III., on "Locomotion: on the Earth; through the Water; in the Air."

Appointment Vacant.—A foreman of plate-laying and bonding is wanted by the Leicester Corporation.

THE CENTRAL STATION ENGINEER.

MR. J. F. C. SNELL, the Sunderland borough electrical engineer, has just paid a visit to the Continent to inspect some three-phase plants.

The staff at the Hastings Corporation electricity works have presented an illuminated address to Mr. L. ANDREWS, late electrical engineer, and now consulting electrical engineer to the Corporation.

Heckmondwike U.D.C. has increased the salary of Mr. CARTER, electrical engineer, from £156 to £200 per annum.

The Llandudno U.D.C. has appointed Mr. DANIEL HUGHES to be second assistant engineer at the electricity works.

At Pinkston Power Station, Glasgow, on Monday last week, Mr. WILLIAM BURR was presented by Mr. JAMES GRAHAM, the superintending engineer, on behalf of the staff and friends, with a case of mathematical instruments, on the occasion of his leaving to take up the position of station superintendent at Reading. Mrs. Burr was also presented with an umbrella.

The Wimbledon D.C. has appointed Mr. H. A. NOTT, of Motherwell, N.B., as mains superintendent at a salary of £120 per annum.

Mr. JOSEPH MCMAHON has resigned his position as chief electrical engineer to the Blackpool and Fleetwood Tramroad, to carry out the construction of the Northampton Tramways in conjunction with the borough engineer. His new address, on and after January 5th, will be Guildhall, Northampton.

NEW COMPANIES REGISTERED.

Wm. Augs. Gibson, Ltd. (75,775).—This company was registered on December 17th, with a capital of £10,000 in £1 shares, to carry on the business of constructors and suppliers of hydraulic, electric, steam and mechanical lifts or elevators, brass and iron founders, metal workers, machinists, &c., and to adopt agreements (1) with W. A. Gibson and (2) with J. A. Steven, P. Steven, and J. M. Steven. The first subscribers (each with one share) are:—P. Steven, Provanside Engine Works, Stirling Road, Glasgow, engineer: J. A. Steven, Provanside Engine Works, Stirling Road, Glasgow, engineer; J. M. Steven, Provanside Engine Works, Stirling Road, Glasgow, engineer; A. A. Dick, 103, Bishop Street, Port Dundas, Glasgow, merchant; F. Pope, 7, High Street, Putney, clerk; W. R. Gibson, 81, Elgin Crescent, W., engineer; E. O. Goss, Vestry House, Laurence Pountney Hill, E.C., solicitor; and W. R. Smith, 1, Lawley Street, N.E., clerk. No initial public issue. The first directors are W. A. Gibson and J. A. Steven (both permanent; special qualification, £1,000); ordinary qualification, £50.

General Electric Inspection Co., Ltd. (75,833).—This company was registered on December 22nd, with a capital of £10,000 in £1 shares, to inspect works, buildings, undertakings, engines, dynamos, machinery, meters, wires, lamps, installations, apparatus and plant, and to carry on the business of electricians, electrical engineers, &c. The first subscribers (each with one share) are:—G. J. Denne, 69, Queen's Road, Wimbledon, business manager; G. A. Veitch, 3, Cromwell Mansions, Ravenscourt Park, accountant; T. S. Webb, 41, Rosemont Road, Acton, W., private secretary; O. F. Spate, Hotel Metropole, London; H. G. Brown, 2, Bond Court, Walbrook, E.C., solicitor; W. J. Simpson, 25, Elaine Grove, Gospel Oak, N.W., clerk; and A. J. Martin, 88, Belton Road, Forest Gate, clerk. No initial public issue. The subscribers are to appoint the first directors; remuneration, £100 each per annum (£150 for the chairman), with an increase according to profits.

Fothergill & Co., Ltd. (75,816).—This company was registered on December 24th, with a capital of £2,000 in £1 shares, to carry on the business of electrical and mechanical engineers, gas fitters, sanitary engineers, builders, contractors, shopfitters, manufacturers of motor cars and electrical machinery, &c. The first subscribers (each with one share) are:—T. Barker, 12, Robin Hood Street, Nottingham, engineer; J. Coxan, High Street, Cheadle, Stoke-on-Trent, electrical engineer; C. J. Cooke, 81, Grange Terrace, Station Road, Wood Green, electrical engineer; J. P. Thorpe, 18, Durham Road, East Finchley, manager; F. Stutchbury, 10, Luna Road, Thornton Heath, retired lighterman; C. A. Henniker, 7, Mincing Lane, E.C., shipping agent; and W. Cook, 7, Mincing Lane, E.C., solicitor. No initial public issue. Table "A" mainly applies. Registered office, 58, Victoria Street, S.W.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Uxbridge and District Electric Supply Co., Ltd. (62,706).—Issue on December 2nd of £2,000, and on December 9th of £500 debentures, part of a series created July 18th, 1901, to secure £20,000 charged on the company's undertaking and property, present and future, including uncalled capital. No trustees. Total amount previously issued of same series, £13,500.

Woking Electric Supply Co., Ltd.—Issue on December 6th of a debenture for £50, part of a series created November 2nd, 1899, to secure £25,000, charged on the company's undertaking and property, present and future, including uncalled capital. No trustees. Total amount previously issued of same series, £18,700.

SUPPLY STATION ACCOUNTS.

Portsmouth Corporation Electricity Accounts.

The accounts we analyse below contain many satisfactory features. A considerable increase in the units sold is accompanied by an actual reduction in the gross expenditure; the increase in gross profit exceeds the increase in the revenue, while a net loss is changed by the two foregoing causes into a comparatively large net profit. That the business is making substantial progress, and has not merely received, for some local or temporary reason, a push forward which will not be maintained, is shown by the improvement in the load factor. We congratulate Mr. E. Price, the electrical superintendent of the Corporation, upon the results he has attained.

General Statement.

	1900.	1901.	Inc.
Total capital expenditure ...	£179,134	£202,062	£22,928
Number of units sold	1,584,821	1,847,790	262,969
Maximum load in KW.	1,506	1,713	207
Gross revenue	£27,215	£32,271	£5,056
Gross expenditure...	£17,540	£17,437	—£103
Gross profit	£9,675	£14,834	£5,159
Average price per unit sold ...	3·90d.	3·89d.	—·01d.

As will be seen, the revenue from sale of electrical energy has risen in almost direct ratio to the increased output, the average price having been only perceptibly changed. Owing to a sum of £705 having been received for relaying conduits for tramways, the receipts from items in the last detailed figure have increased. In other particulars the revenue statement remains practically unaltered in the average.

Revenue Statement.

	1900. Gross	1900. Per unit.	1901. Gross	1901. Per unit.	Inc.
Sale of energy	£25,775	3·90d.	£29,926	3·89d.	—·01d.
Meter rents	989	·15d.	1,202	·16d.	+·01d.
Sale of old material, lamps and other apparatus	297	·05d.	330	·04d.	—·01d.
Sundry fees, rents and legal costs returned.	154	·02d.	813	·10d.	+·08d.
Gross revenue ...	£27,215	4·12d.	£32,271	4·19d.	+·07d.

The costs show some changes; repairs, rates and taxes and establishment charges have risen, the first-mentioned considerably, but owing to large decreases in coal and in wages, the works costs have dropped to under 2d.—an improvement approaching ¼d. per unit, and this has been practically maintained in the total cost, which, at just over 2¼d., is extremely good for a works not favourably situated for coal supply.

Cost of Production.

	1900. Gross.	1900. Per unit.	1901. Gross.	1901. Per unit.	Inc.
Coal	£9,670	1·46d.	£8,555	1·11d.	—·35d.
Oil, waste, water and engine room stores.	1,090	·16d.	888	·11d.	—·05d.
Salaries and wages incurred in generation and distribution and attending street lamps.	2,354	·36d.	1,332	·17d.	—·19d.
Repairs and maintenance of buildings, engines, boilers, dynamos, and repairs to public lamps.	2,224	·34d.	3,740	·49d.	+·15d.
Works costs ...	£15,338	2·32d.	£14,515	1·88d.	—·44d.
Rent, rates and taxes ..	515	·08d.	987	·13d.	+·05d.
Management expenses, salaries of managing engineer, secretary, clerks, &c., and audit fees.	1,361	·21d.	1,486	·19d.	—·02d.
General establishment charges, stationery and printing, law charges and insurance.	320	·05d.	449	·06d.	+·01d.
Other expenses, compensation, &c.	6	·00d.	—	—	·00d.
Total costs ...	£17,540	2·66d.	£17,437	2·26d.	—·40d.

Owing to the revenue increasing by £5,056, and the expenditure decreasing by £103, the gross profit has risen by £5,159. At the same time the financial charges only took £10,525 as against £10,543, being a reduction of £18. The net profit was, therefore, £5,177 better than in 1900, and consequently not only was the net loss in that year of £868 covered, but a net profit of £4,309 remained. Of this amount £2,000 was placed to the reserve fund, £1,250 was allocated to the provision of a new workshop, and £1,059 remained in hand to be carried forward.

Profit Statement.

	1900.	1901.
Interest on loans, overdraft, and deposits	£5,600	£5,257
Sinking fund for repayments	4,943	5,268
Reserve fund	—	2,000
Provision of new workshop	—	1,250
Balance carried forward	— 868	1,059
Gross profit	£9,675	£14,834

CITY NOTES.

J. G. White & Co., Ltd.

The report of directors (second annual) to August 31st, 1902, which was presented to the meeting held on Monday last at College Hill, E.C., reads as follows:—"The statement deals with actual results of contract and engineering work completed to the date named, and estimates have been eliminated as far as possible. The satisfactory profit shown is due to the large volume of business which is being handled by the company. For the latter part of the year covered by the accounts, and for the period since September 1st to date, the average monthly turnover of business has been about £75,000. The principal contracts under construction during the year, the profits (on the completed portions only) of which are brought into the present account, were:

1. The Auckland (N.Z.) electric tramways, 28 miles. These lines were formally opened for traffic on November 17th, 1902, and the whole of the system is expected to be completed, subject to maintenance, in the early part of 1903.
2. The power plant of the Kalgoorlie Electric Power and Lighting Corporation, Ltd., at Kalgoorlie, Western Australia. This plant was completed and formally transferred to the Kalgoorlie Corporation on September 21st, 1902.
3. The conduit and road construction for electric traction of the Tooting lines of the London County Council (conduit system), 16¼ miles, practically the whole of which will be completed by the close of the present year.
4. The permanent way and overhead construction of the Bournemouth Corporation tramways (combined overhead trolley and slot conduit), 16 miles, which will be completed prior to December 31st, 1902.
5. The permanent way and overhead construction of the Barnsley and district light railways. Completed at the date of this report, subject to maintenance.
6. The permanent way and overhead construction of the Peterborough and district light railways; nearly completed.
7. The overhead construction of the Wolverhampton and Dudley tramways. Completed at date of report, subject to maintenance.
8. The permanent way and overhead construction of the Sheerness tramways; practically completed.

"In addition to the above, a number of smaller contracts for the supply of machinery and plant, engineering, examinations, reports, &c., were dealt with, and the directors are pleased to state that all business carried out during the year resulted in a profit to the company. To refer briefly to the principal items in the accounts:

Creditors on open accounts and provision for accrued charges, loans, and bills payable. This amount appears large, owing to heavy purchases of material and outlay for tools and plant during July and August, payments for which did not take place until after the date of the balance-sheet. Practically the whole of these amounts have now been paid off.

The investments have been valued at a very conservative figure, which is considerably below what could be realised at the present date.

The customary depreciation of 10 per cent. of cost has been written off office furniture, instruments and books.

The plant and tools are valued at practically 40 per cent. below cost, all repairs and renewals having been written off to revenue.

Materials on hand and work in progress are valued at their actual cost to the company, and the amount shown has, since the date of the accounts, been certified in connection with the various contracts at a profit.

Ample provision has been made to cover possible loss in collection of open accounts receivable and contract retentions.

In the profit and loss account the item "prospective business written off," represents the total expenditure to August 31, 1902, on schemes, tenders, &c., which have not directly matured in business up to the present date. A considerable portion of this expenditure represents outlay on business which is still in course of negotiation, and from which profitable contracts are expected to be secured.

The cost of patents is also debited to profit and loss, although the directors believe that the patents secured are of considerable value to the company.

"Your directors believe that all liabilities of the company at August 31st, 1902, have been charged or provided for, and that the accounts as now submitted show the result of the year's work on a conservative basis.

"The balance of the profit and loss account, including £3,649 16s. 11d. brought from last year, is £29,418 13s. 3d., and this your directors recommend should be dealt with as follows:

In payment of a dividend, free of tax, at the rate of 8 per cent. per annum on the 6 per cent. cumulative preference shares to August 31st, 1902	£3,918 14 9
In payment of a dividend, free of tax, on the ordinary shares for the year to August 31st, 1902, at the rate of 8 per cent. per annum	4,000 0 0
To reserve fund, in accordance with Article 115 of the Articles of Association	10,000 0 0
To carry forward to next year's accounts	11,469 18 6
	£29,418 13 3

"If the above recommendations are adopted, it will be seen that, after the creation of a reserve fund of £10,000, the balance of profits carried forward to next year's accounts is nearly sufficient to provide a dividend at the rate of 8 per cent. per annum on the full authorised preference and ordinary share capital of the company. The directors are pleased to be able to state that the company is continuing to secure a large amount of business. The aggregate amount of work recently secured, in addition to the contracts dealt with in the accounts now submitted, is over £660,000. This includes contracts from the London County Council, the Middlesex County Council, the Wigan Corporation, the Bexley Heath Urban District Council, and construction and engineering work on the Continent, notably for tramways from Amsterdam to Haarlem (Holland) and at Lille (France). Negotiations are now proceeding which are likely to result in further business being secured within the next few months. The directors are pleased to be able to assure you that the business of the company is in a very satisfactory condition, and the future prosperity may be looked forward to with confidence. Since the date of the balance-sheet, the whole of the unsubscribed preference share capital of the company has been placed, and the funds available are ample for present requirements. For various business reasons it has been decided that the next statement of accounts shall be made up for a period of six months to February 28th, 1903, and in future the fiscal year will end on the last day of February in each year. The retiring directors are Messrs. J. G. White and W. C. Burton, who, being eligible, offer themselves for re-election. The auditors, Messrs. Monkhouse, Stoneham & Co., also retire, but, being eligible, offer themselves for re-election."

Lord ARTHUR BUTLER presided at the meeting of the company, in the absence in the United States on business of Mr. J. G. White. He said that there was little to say beyond congratulating the shareholders upon a very successful year's operations. There was every reason to suppose that the present year would be equally successful. They hoped to call the shareholders together again in May to pass the accounts to February, 1903.

Mr. A. N. CONNETT seconded the adoption of the report, also the resolution declaring 8 per cent. on the preference and ordinary shares. Both resolutions were unanimously passed, and, after the retiring directors and auditors had been re-elected, a vote of thanks brought the proceedings to a close.

British Electric Traction Co., Ltd.

THE following is a copy of the directors' interim report to December, 1902. It accompanied the interim dividend on the ordinary shares at the rate of 6 per cent. per annum for six months ended September 30th, 1902:—

"It has been the custom to issue a short report with the interim dividend. On this occasion the directors think it opportune to deal rather more fully with the affairs of the company than usual because several shareholders have asked for information in consequence of the attacks which have been made upon the company by advocates of municipal trading. The company has built up a very large business by doing work which, until the advent of the company, was neglected. The undertakings which the company has established are, for the most part, of a kind which local authorities were unable or unwilling to carry out. Most of the schemes which the company has successfully carried out would never have been initiated if left to municipalities. The associated companies are on excellent terms with most of the numerous local authorities in the United Kingdom (upwards of 200) within whose districts they are carrying on operations. The advocates of municipal socialism, however, viewing with jealousy the progress of the company, are making efforts to discredit it in the eyes of the local authorities by mis-statements of every description; and the denials and corrections made by the company are either ignored or perverted.

"As a matter of fact, the company, whilst it has been engaged in establishing a large number of undertakings in districts where municipalisation would have been quite impossible, has indirectly stimulated municipalities to adopt electric traction.

"When the B.E.T. (Pioneer) Co. was formed in 1895 there were only about 50 miles of electric tramways in the United Kingdom, and the overhead system of electric traction was very much out of favour. There are now upwards of 2,500 miles of tramways on this system in operation or authorised in this country. This result has been brought about principally by the exertions of the company. During the past seven years the company has investigated more than 600 different schemes, in regard to a large proportion of which proposals have been submitted to local authorities and others. In many cases the fact that the company was prepared to do the business induced the local authorities to undertake enterprises which, but for the advocacy and example of the company, would never have been considered by them.

"A misrepresentation which is now persistently put forward in order to prejudice the company is to the effect that the British Electric Traction Co. is an American organisation. At a recent meeting of one of the associated companies Sir. C. Rivers Wilson stated:—

Another mis-statement which had been persistently circulated in the local Press was to the effect that the British Electric Traction Co. was under American control. The directors instructed the secretary to write an official denial of this statement, but one of the leading Birmingham papers, while inserting the letter, appended a footnote stating that they had it on excellent authority that Mr. Pierpont Morgan held 400,000 shares in the company, which, by the way was nearly double the total issued capital of the company at the time. It was subsequently stated in another Birmingham paper that the "American origin, holding, backing and direction of the British Electric Traction Co. are matters of sufficient notoriety." He wished to state emphatically that there was absolutely no American element in the origin, backing or direction of the company, and the American holding in the company was insignificant compared with the total capital.

"With the same object the company is referred to as the Electric Trust, but again the facts do not support the insinuation that the company's business is inimical to the interests of the public. The company's business is to construct and work electrical undertakings authorised by Acts of Parliament or Orders of the Board of Trade, which fully protect the interests of the public.

"The chief points in regard to which some shareholders have asked for information are:—

I. What are the objects for which the additional capital has been raised?
II. What is the proportion of profits earned from the current and recurring operations of the company as distinguished from the profits made on promotions, financing and other sources of a more or less fluctuating character?
III. What is the provision made for depreciation of assets?

"The directors therefore propose to give full information on these three points.

"I.—*Capital Expenditure.*—Since the date of the last balance-sheet, March 31st, 1902, the company has issued further share and debenture capital to the amount of £1,020,168
The net premiums on which amount to about... ... 80,000

£1,100,168

Of this sum £321,400 has still to be paid up, and £310,030 was issued in fully paid-up shares in exchange for shares in the Brush and the E.P.D. Companies, as mentioned below.

"During this period the following approximate amounts of capital have been expended upon associated undertakings, particulars of which are given in the last annual report, to which shareholders are referred:—

"£32,130 in exchange for ordinary shares in the Brush Electrical Engineering Co., Ltd.

"£114,470 in exchange for preference shares in that company.

With regard to this investment, your directors are quite satisfied as to the soundness of the policy which dictated it, and they have no doubt that as soon as the re-organisation, which is being carried out, has had time to make itself felt, the investment will prove profitable.

"£163,825 in exchange for or purchase of shares in the Electrical Power Distribution, Co., Ltd., and £21,500 has been advanced for the development of that company's various undertakings.

The business established by the E.P.D. Co. is still in course of development. Many of the power stations have only lately been started, and the electric supply business takes two or three years to become remunerative, but, nevertheless, the aggregate rate of output of all the power houses of the E.P.D. undertakings already amounts to over 4,000,000 units per annum. This progress compares favourably with that of some of the largest electric supply concerns in the country. The combined use of electric power stations for tramways, for industrial power purposes, for lighting, &c., as foreshadowed in previous reports, is having a satisfactory effect upon the revenue returns.

"£241,186 in shares of the Auckland Electric Tramways Co., Ltd.

The Auckland Co. has completed the construction of 3½ miles of double line, which were opened for electrical running on November 17th last. A further 13½ miles, mostly double line, will be completed early next year.

"£26,807 advanced to the Barnsley and District Electric Traction Co., Ltd.

The Barnsley Co. has just completed the construction of three miles of electric tramways, which were opened for traffic on November 7th last.

"£101,372 in purchase of shares in the City of Birmingham Tramways Co., Ltd.

The purchase of these shares by the company seems to have directed the attention of the advocates of municipal socialism to the important work which the company has done in the Birmingham district, and, in order to prejudice the company, some very extraordinary mis-statements have been made as to the company's objects and methods, but the position has not been materially affected thereby.

The Birmingham company holds leases from the Corporation which do not expire until 1906 and 1911, and negotiations are now being initiated with the Corporation for the conversion of the lines to electric traction, and for the extension of the leases. Most of the lines outside Birmingham are controlled by the B.E.T. Associated Companies, and a Bill is being promoted in the present Session of Parliament in conjunction with local authorities outside Birmingham to provide for the efficient working of the tramways in and adjacent to the City of Birmingham and for securing, through services of cars from the outside districts into the City, and to enable the Birmingham Co. to construct additional tramways, and for other purposes.

"£9,349 in purchase of the Airdrie and Coatbridge tramway undertaking.

"£21,844 advanced to the Gravesend and Northfleet Electric Tramways, Ltd.

The Gravesend Co. has recently completed the construction of 6½ miles of electric tramways, which were opened for traffic in August last.

"£83,810 invested in shares and debentures of the Middleton Electric Traction Co., Ltd.

The Middleton Co. owns 8½ miles of electric tramways, which were opened for traffic in March last.

"£15,000 advanced to the Peterborough Electric Traction Co., Ltd.

The Peterborough Co. is now constructing 5½ miles of electric tramways which it is expected will be opened for traffic early in the new year.

"£3,000 advanced to the Rothesay Tramways Co., Ltd.

The Rothesay Co. has recently reconstructed for electric traction its horse tramways, about 2½ miles. Electrical working was commenced in August last.

"£36,063 advanced to the Southport Tramways Co., Ltd.

The Southport Co. has recently reconstructed for electric traction, and is now working, about 6 miles of tramways in Southport and Birkdale; and also owns the electric lighting undertaking in Birkdale, which has just been started.

"£82,124 advanced to the Wolverhampton District Electric Tramways, Ltd.

The Wolverhampton Co. has recently completed the reconstruction of horse tramways and the construction of extensions, all for electric traction. Total 14½ miles.

"£18,803 advanced to the Wrexham and District Electric Tramways, Ltd.

The Wrexham Co. is constructing 5 miles of tramways.

"£81,071 advanced to the Yorkshire (Woollen District) Electric Tramways, Ltd.

The Yorkshire Co. is constructing an important system of 31 miles of tramways in the vicinity of Huddersfield, Dewsbury, Bradford, Leeds and Morley, and a portion of the system is expected to be opened for public traffic early in the new year.

"As this is not a balance sheet, but a general statement, it is not proposed to mention all the transactions that have taken place since March last; it will, however, be of interest to the shareholders to know that the company is now also largely concerned in the Metropolitan Electric Tramways, Ltd., and various sums of capital are being provided for that company which has made arrangements with the Middlesex and Hertfordshire County Councils by which the light railways to be constructed in these counties (45 miles) are to be leased to the company for 30 and 42 years respectively. The Metropolitan Electric Tramways, Ltd., has recently purchased 7½ miles of tramways now worked by horses in the County of Middlesex, and also holds the majority of shares in the North Metropolitan Tramways Co., which holds a lease from the London County Council for 55 miles of tramways now worked by horses but about to be converted to electric traction, and has recently acquired the majority of the shares of the Harrow Road and Paddington Tramways Co. Altogether the total mileage of tramways and light railways controlled by the company and its associated companies is 570 miles, and in addition there are about 58 miles of omnibus routes. A large proportion of these lines is in operation by electricity, steam, or horses, and the associated companies are carrying over 100,000,000 passengers per annum, with gross receipts of over £700,000 per annum. As will be seen from the above, further lines are in course of conversion or construction for electric traction.

II—Analysis of Profits.—The profits of the company are derived not only from dividends on its investments, but from a large variety of other sources. The procedure of the company in regard to the traction business has been to acquire the control, either by purchasing the undertaking, or the majority of the shares of the company owning it, or by obtaining leases, of tramways worked by horses or steam, to promote Parliamentary and other powers for new tramways or light railways, and to carry out the conversion of old lines and the construction of new lines for electric traction. This is generally done on behalf of associated companies, which undertake the working of the lines, and in which the company remains interested, for the most part, as a holder of ordinary shares. The officers of the company generally provide most of the services required for these various operations, which include parliamentary, financial, engineering and administrative duties, and all fees paid by associated companies to directors and officers of the company in respect of such services accrue to the company. Probably the best way of explaining to the shareholders the character and nature of the work done by the company and of the profits earned is to take a concrete case. With this view it is proposed to explain the work done and the profits earned in connection with the Tynemouth and District Electric Traction Co., Ltd. The case of the Tynemouth company is typical of many others, but although the numerous other cases may be in most respects similar in kind, they vary considerably in degree both as to services rendered and remuneration received.

The North Shields and Tynemouth Tramways Co. was formed many years ago, and the company had nothing to do with it till 1897. The capital then consisted of 6,000 shares of £1 each, and the company purchased the majority of shares at £1 2s. 6d. per share. The Tynemouth Co. owned two miles of steam tramways. It carried about 300,000 passengers, and earned a profit of about £400 to £500 per annum, which enabled it to pay a dividend of 4 per cent. to 5 per cent. per annum. The local authorities had been asked to extend the lines and had declined to do so, and the shareholders were unwilling to embark fresh capital as the tenure under the Tramways Act had only a few years to run. Upon obtaining control of the undertaking the company negotiated arrangements with the local authorities for the extension of the tenure for 21 years, and for the conversion of the line to electric traction. An extension of two miles under the Light Railways Act with a tenure of 35 years was also promoted and obtained, and an agreement was made with the Corporation of Tynemouth to supply electrical energy. There was considerable opposition to the scheme, and public meetings had to be held to explain to the inhabitants the nature of the overhead system of electric traction.

When all these negotiations and arrangements had been completed, which took about two years, the name of the Tynemouth Co. was changed, and powers were taken to increase the capital from £6,000 to £80,000, half in ordinary shares and half in preference shares of £5 each, with power to issue £40,000 debentures. The new Light Railway Order and the various agreements made with the local authorities were transferred to the Tynemouth Co. in consideration of £5,000, of which about £1,500 represented expenses. The company then subscribed for the balance of the ordinary shares, a public issue was made of £40,000 preference shares, and the tramways and light railways were constructed and adapted for working by electric traction. The lines were re-opened in March, 1901, and for the 9½ months to the end of the year 1901 the receipts amounted to £11,069 and the expenses to £5,700, leaving a net profit of £5,369, of which £1,000 was placed to depreciation fund, £900 applied to payment of preference dividend, and £2,800 to payment of 7 per cent. on the ordinary shares for the whole year, the balance of £669 being carried forward. The board of the Tynemouth Co. consists of two nominees of the company and two local shareholders.

The Tynemouth Co. is now carrying about 2,000,000 passengers per annum, and the undertaking is so popular that the local authority requested an extension of the lines to Whitley Sands. The company acted as engineers for the construction of the lines, and received a sum of about £4,103, being 4 per cent. on the total cost of construction and equipment of the lines, for engineering services. The £5 ordinary shares are now selling at £6 2s. 6d., and 483 shares have been sold at a profit of £464 16s. 1d. The company has also received £41 8s 1d. in respect of directors' fees, £76 4s. 8d. for office accommodation, &c., £70 2s. 9d. for interest on loans, and £66 5s. 9d. for sundry other fees. The company holds 7,480 ordinary shares and 4,480 preference shares in the Tynemouth Co. which stand in the books at a cost of £60,276, and yield an average dividend of 6¾ per cent., or more than the average cost of the company's capital on the basis of a 9 per cent. dividend on the ordinary shares.

"The following is an analysis of the profits shown in the audited accounts of the company for the past five years. The directors consider that this analysis shows a very satisfactory progress, not only in the amount of the profits, but more particularly in the proportion of profits derived from dividends and other sources of a recurring character, as compared with the profits derived from sources which are more fluctuating.

Analysis of Profits for periods ended December 31st, 1897, December 31st, 1898, March 31st, 1900, March 31st, 1901, and March 31st, 1902.

	14 months ended Dec. 31st, 1897.	12 months ended Dec. 31st, 1898.	15 months ended March 31st, 1900.	12 months ended March 31st, 1901.	12 months ended March 31st, 1902.
Dividends, interest, fees and commissions	£3,244 12 9	£18,199 16 11	£62,859 12 11	£72,621 4 4	£156,266 12 7
Profits on working of lines, on sales of investments and materials, rents and sundry profits	4,593 9 8	6,006 19 6	11,081 0 6	4,110 7 5	14,131 4 2
Profits on sales of undertakings and of Parliamentary Powers and underwriting profits	6,742 8 9	47,500 0 0	75,233 9 9	59,029 9 11	77,838 0 5
	£14,580 11 2	£71,706 16 5	£149,174 3 2	£135,761 1 8	£248,235 17 2
Less expenses and sundry losses chargeable against above profits	157 16 5	3,511 11 4	25,503 1 10	22,162 2 11	44,965 17 4
As per published profit and loss accounts	£14,422 14 9	£68,195 5 1	£123,671 1 4	£113,598 18 9	£203,269 19 10

"III.—*Question of Depreciation.*—Some misapprehension appears to exist in regard to this matter. It is assumed because no separate depreciation or sinking fund appears in the company's balance-sheet, that no provision whatever is made for depreciation, but this is not the case. The major part of the capital of the company is invested in shares and debentures of other companies. All these companies deal with the question of depreciation according to their respective circumstances and requirements. Their accounts are separately audited, and have been reproduced in the appendix to the annual report of the company. For the year 1901 the various associated companies wrote off, reserved or carried forward out of the profits of the year £108 500, which is equal to about 2½ per cent. of their aggregate subscribed capital. Considering that many of the undertakings had only recently been started, the provision thus made is, in the opinion of the directors, ample. It must, moreover, be remembered that this company has placed to reserve all the premiums received on new capital, amounting to £519,705, and has also applied out of profits to writing down or reserve and carry forward up to March last £93,881, and that the valuable goodwill of the company has been written down to the nominal figure of £1,000.

"In conclusion, the directors think it well to remove a misconception on the part of some shareholders who express surprise that the company's capital has been increased by instalments, but regard should be had to the fact that when the company made its first issue of £300,000 in November, 1896, it had a business comprising only about 35 miles of tramways, and that it now controls more than 16 times that mileage, with less than a proportionate increase of capital. The fact that capital has been raised from time to time as the business required, has enabled larger dividends to be paid than would have been possible if any other course had been pursued."

The Siemens & Halske Co.

The report of this Berlin company, which has a share capital of £2,725,000 and loans amounting to £1,461,500, shows that both the gross and the net profits for 1901—1902 are lower than at any time during the past six years, and they only enable the payment of a dividend at the rate of 4 per cent., as against 8 per cent. a year ago and 10 per cent. in each of the four preceding years. The gross profits amount to £316,900, and the net profits to £189,282, as against £324,149 in 1900—1901, and £353,095 in the previous year, the value of the total turnover being £4 200,000, or 6 per cent. less than in the preceding 12 months. It is pointed out by the directors that the year's results were partly influenced by the grants of £52,000 which the company was compelled to make to the electric railways and central stations worked by it on lease. With regard to the general situation, the report states that it appears that a stop in the downward movement has taken place, although it cannot at present be seen how long the pressure on the trade will continue. The directors are, however, convinced that sooner or later a revival will take place, and that the development of the company and its spheres of activity will again make progress. The electrical industry has without any doubt had to suffer from the

consequences of mistakes, but the company has not exceeded actual requirements in the extensions carried out at Berlin and Charlottenberg, and at the time of heavy demands it was impossible to give to certain branches the enlargements which corresponded with the possibilities of sales. Indeed, it is only in the cable factory at the Westend, Berlin, and the Leopoldau machine works near Vienna that the equipment and buildings are somewhat large for existing conditions. But regarded from a general standpoint, the extension of the company's shops has not proceeded disproportionately to the present requirements of the market. An important progress is anticipated from the telephone invention of Prof. Pupin, of New York, the European patent rights of which have been acquired by the company. After referring to the severity of competition and the disastrous results of price-cutting, the report submits that the nervousness in the industry is beginning to subside, and it then deals with the suggestions made in various quarters that the only remedy for overcoming the present depression lies in the amalgamation of the large competitive firms. On this point, however, the report states that more self-consciousness and confidence in one's own strength, at all events, exist in the industry, and it is not impossible that, with a greater clearing up of the situation, a way will be found for bringing about a more uniform organisation within certain limits and of a more effective character than has hitherto been possible. The company also will not be unprepared to take the initiative in this direction, but, at the same time, the directors consider that independent action is necessary if the German electrical industry is to be maintained in the van of technical progress.

Official Announcements re Companies.

The following companies have been struck off the register:—

Adams Electrical Generator Co., Ltd.
British Electric Railways, Ltd.
H. & H. Accumulator Syndicate, Ltd.
Hawley Smokeless Economiser Furnace Co., Ltd.
Hertford Engineering Co., Ltd.
Medical Battery Co., Ltd.
Middlesex and Hertford Electric Lighting and Power Co., Ltd.
Ossett Engineering Co., Ltd.
Rail and Tram Share Syndicate, Ltd.
Rotary Piston Engine Co., Ltd.
Seaside Electric Laundry Co., Ltd.
Smoke Preventer and Fuel Economiser, Ltd.
United States and Canadian Rhea Rubber and Insulite Syndicate, Ltd.
Volt Electrical Co., Ltd.
West of England Electric Installation Co., Ltd.
World Gas and Electric Syndicate, Ltd.

The following will be struck off in three months unless cause is shown to the contrary:—

Electrical Transport and Power Co., Ltd.
Leeds Electrical Supply Co., Ltd.

Stock Exchange Notices.—The Committee has been asked to allow the following to be quoted in the Official List:—Willans & Robinson, Ltd.—£135,000 4 per cent. first mortgage debenture stock, in lieu of the scrip, and to be added to the stock now quoted in the Official List. The Committee has ordered the undermentioned securities to be quoted in the Official List:—Bournemouth and Poole Electricity Supply Co., Ltd.—7,500 6 per cent. cumulative second preference shares of £10 each, fully paid, Nos. 15,001 to 22,500. Electrolytic Alkali Co., Ltd.—29,233 vendors' ordinary shares of £1 each, fully paid, Nos. 35,001 to 58,146 and 68,914 to 75,000.

Charing Cross and Strand Electricity Supply Corporation, Ltd.—Warrants for the dividend on the City undertaking 4½ per cent. preference shares have been posted. Warrants for the interest on the 4 per cent. debenture stock of the corporation have also been posted.

South Lancashire Electric Traction and Power Co., Ltd.—Warrants for the interest to December 31st on the 4½ per cent. first mortgage debenture stock were posted on Wednesday.

Crompton & Co., Ltd.—Interim dividends for the half-year ended September 30th last, at the rate of 5 per cent. per annum, free of income-tax, are payable on January 15th.

Edmundson's Electricity Corporation.—The directors have declared a dividend of 5 per cent. on the ordinary shares for the six months ending September 30th last.

STOCKS AND SHARES.

Wednesday Evening.

The New Year, with all its usual promise and hopefulness, will be already a day old when first these notes see their readers, but from the dying moments of 1902 a few minutes may be snatched to show how prices have moved in the electrical markets. Taken all round, the year has not been a bad one for the securities dealt with in this column. Business, if not brisk, has been consistently steady, and when it is remembered that Consols are down 1 per cent. since last year began, it is not astonishing that some of the investment securities have followed their lead.

To begin with the little Home Railway market in electrical stocks and shares, this is how the excellent result of the year 1902 pans out:—

Stock.	Dec. 31, 1901.	Dec. 31, 1902.	Rise.
Central London Ordinary ..	106½	108½	2
" " Preferred ..	106½	106½	No change.
" " Deferred ..	107½	109½	2
City & South London Ordinary	63	76	13
Metropolitan District	29	37	8
Waterloo and City	92½	95½	3

In these figures, at all events, there is no cause for complaint, and to our list of railway stocks it may be added that British Electric Traction Ordinary were 14 a year ago, while now they stand at 12⅜. London United Tramway Debenture has risen from 103 to 104.

As a contrast to these satisfactory statistics must be placed the fluctuations in telegraph securities. Nearly all the changes are on the downward plane, thanks mainly to the enterprise of Marconi and the opening of the new Pacific cable. Here is a little list, representative of the general market:—

Stock.	Dec. 31, 1901.	Dec. 31, 1902.	Fall.
Anglo Preferred	92½	90	2½
Anglo Deferred	8¼	8¼	No change.
Direct U.S.	10	10	No change.
Eastern Ordinary	135	117½	17½
Eastern Extension	13½	10½	3
Great Northern	31	26½	4½
Western Telegraph	12½	11¼	1¼

It is good to be able to record that at the very end of the year a better tone became noticeable in the Anglo-American group and several others, the Marconi scare having been overdone. In connection with this market it may be noted that Globe Telegraph Ordinary were 9½ a year ago and are now 8⅜, while Submarine Cables Trust Certificates have 122½ and 115 respectively for their quotations at the beginning and the end of 1902.

Investors in electricity supply shares will study with interest the changes that have taken place in this department. Various new issues that were made during the past twelvemonth found ready support when the price offered any attraction whatever to those who had the option of taking fresh stock or shares. The amounts have not been particularly heavy, and there is still a brisk demand for all gilt-edged electrical securities, while the shares in this section continue in favour with those who are content to put their money into sound undertakings, even though there be no element of speculation attached to the investment. Some of the chief shares are herewith set forth, and the changes which have occurred during the year just closed:—

Shares.	Dec. 31, 1901.	Dec. 31, 1902.	Rise or fall.
Brompton	9	10½	+1½
Charing Cross and Strand ..	8½	9½	+1
Chelsea	5⅝	5⅜	− ¼
City of London	9½	10¾	+1¼
County and Brush	9	9	No change.
Edmundson's	5⅜	6⅛	+ ⅜
Kensington	11½	10½	−1
Metropolitan	14½	16	+1½
Notting Hill	15½	14½	−1
St. James's	16	15	−1
Westminster	12	11½	− ½

For a year which has been decidedly unfavourable to purely investment shares, the above list must be regarded as certainly good. Brush Ordinary, it may be mentioned, began 1902 at 1½ and ended it at 1, while South Londons climbed from 2½ up to 3¼. Smithfield Market shares were 2¼ then, and are just the same now.

The amalgamation of Callender's with Henley's, so nearly consummated, nevertheless failed to take place owing to a hitch in the negotiations, but perhaps 1903 may see the union at last effected. The prices of both shares stood at 17 a year ago, whereas now Henley's are still 17, and Callender's 14½. But the Telegraph Manufacturing Co. has joined forces with the British Insulated Wire, and to-day the shares of the new concern command 7⅞. Telegraph Constructions have scarcely moved from the level of 39½, at which they stood on the New Year's Day of 1902.

The course of prices in the current twelvemonth is, of course, difficult to forecast even approximately, but it may be said that with the return of confidence and capital to more normal channels, now that the war is being gradually forgotten, there should come a steady strengthening of investment stocks and shares throughout all departments of the Stock Exchange. In such a movement assuredly the electrical sections will have a full share, and the development of the latest system of traction should also provide a good deal of speculation of various kinds.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1899.	1900.	1901.	Closing Quotations Dec. 22nd.	Closing Quotations Dec. 31st.	Business done week ended Dec. 31st, 1902. Highest	Lowest
67,100	African Direct Telegraph, 4 % Debs.	100	..	..	..	98 —102	98 —102	..	..
25,000	Amazon Telegraph Co.'s shares, Nos. 1 to 25,000	10	..	..	..	2⅛— 3⅛	2⅛— 3⅛	..	..
119,700£	Do. do. 5 % Debs., Nos. 1 to 1,250 Red.	100	..	..	..	70 — 80	70 — 80	..	..
788,840	Anglo-American Telegraph	Stock	7s/6	3½%	6½s.	49 — 52	48 — 51	..	..
3,105,580	Do. do. do. 6 % Pref.	Stock	6 %	6 %	6 %	92 — 94	89 — 91	90½	89½
3,105,580	Do. do. do. Deferred	Stock	£1 7s.	5s. %	2s.	8 — 8⅝	8⅝— 9	8⅛	..
44,000	Chili Telephone, Nos. 1 to 44,000	5	4 %	5 %	5 %	4 — 4⅓	4 — 4⅓	..	..
13,333,300$	Commercial Cable	$100	8 %	8 %	8 %	178 —188	170 —180	..	..
1,841,209	Do. do. Sterling 500 year 4 % Deb. Stock Red.	Stock	..	..	..	94 — 96	73 — 75 xd	..	..
16,000	Cuba Telegraph	10	7 %	4½%	4 %	5 — 6	5 — 6	..	..
6,000	Do. 10 % Pref.	10	..	..	..	13 — 14	12⅞— 13⅞	..	..
12,931	Direct Spanish Telegraph	5	4 %	4 %	4 %	2⅞— 3⅛	2⅞— 3⅛	..	..
6,000	Do. do. 10 % Cum. Pref.	5	..	..	..	7 — 8	7 — 8	..	..
60,710£	Direct United States Cable	20	3½%	3½%	3½%	10 — 10½	9¾— 10¼	10⅛	9⅞
92,800£	Direct West India Cable, 4½% Reg. Deb., within Nos. 1 to 1,200, Red.	100	..	..	..	100 —103	98 —101 xd	..	..
4,000,000	Eastern Telegraph, Ord. Stock	Stock	7 %	7 %	7 %	122 —127	115 —120	118	115
1,955,565	Do. 3½ % Pref. Stock	100	..	..	..	89 — 92	89 — 92	89	..
1,534,645	Do. 4 % Mort. Deb. Stock Red.	Stock	..	..	..	105 —108	105 —108	105⅝	105
300,000	Eastern Extension, Australasia, and China Telegraph	10	7 %	7 %	7 %	10⅞— 11⅛	10 — 11	11	10½
320,000£	Do. 4 % Deb. Stock	Stock	..	..	..	107 —110	107 —110	..	..
300,000	Eastern & South African Tele., 4% Mt. Db., Nos. 1 to 3,000, red. 1909	100	5½%	..	..	99 —102	99 —102	..	..
200,000£	Do. do. 4 % Reg. Mort. Debs. (Mauritius Sub.) 1 to 8,000	25	..	..	..	99 —102 %	99 —102	..	..
180,227	Globe Telegraph and Trust	10	5½%	5½%	5½%	8½— 9	9 — 9⅛	8⅝	..
180,042	Do. do. 6 % Pref.	10	..	..	..	13 — 13½	13 — 13½	12⅝	12½
150,000	Great Northern Telegraph, of Copenhagen	10	12½%	15 %	15 %	26 — 27	26 — 27	..	..
66,300£	Halifax and Bermudas Cable, 4½ % 1st Mort. Debs., within Nos. 1 to 1,200, Red.	100	..	..	..	100 —103	100 —103	..	..
17,000	Indo-European Telegraph	25	10 %	10 %	10 %	39 — 43	39 — 43	..	..
100,000£	London Platino-Brazilian Telegraph, 6 % Debs.	100	..	..	..	101 —105	101 —105	..	..
72,680	Montevideo Telephone, Ltd., Ord. Nos. 1 to 72,680	1	2½%	..	..	⅛— ¼	⅛— ¼	..	..
86,492	Do. do. 5 % Pref., Nos. 1 to 86,492	1	5 %	..	..	½— 1	½— 1	..	..
1,988,333	National Telephone, Pref. Stock	100	5 %	5 %	5 %	92 — 94	94 — 96	95½	93½
1,966,667	Do. do. Def. Stock	100	..	60	64 xd	63 — 65	65 — 68	..	..
15,000	Do. do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	12½— 13½	12½— 13½	..	..
15,000	Do. do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	11½— 12½	11½— 12½	..	..
250,000	Do. do. 5 % Non-cum. 3rd. Pref., 1 to 250,000	5	5 %	5 %	5 %	5⅛— 5⅜	5⅛— 5⅜	5⅜	..
2,000,000£	Do. do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½%	95 — 98	93 — 96 xd	..	..
600,000	Do. do. 4 % Deb. Stock Red.	100	..	4 %	4 %	101 —105	99 —103 xd	..	..
171,504	Oriental Telephone and Elec. Nos. 1 to 171,504, fully paid	1	5 %	6 %	6 %	⅞— 1	⅞— 1	..	..
100,000£	Pacific and European Tel., 4 % Guar. Debs., 1 to 1,000	100	..	..	..	99 —102	97 —100 xd	..	..
11,889	Reuter's	8	5 %	5 %	5 %	6½— 7½	6½— 7½	..	..
3,308	Submarine Cables Trust	Cert.	..	..	..	110 —120	110 —120	112	..
58,000	United River Plate Telephone	5	7 %	7 %	7 %	5 — 5½	4⅞— 5⅛ xd	..	..
40,000	Do. do. 5 % Cum. Pref., Nos. 1 to 40,000	5	..	..	..	4½— 5	4½— 5 xd	..	..
179,947£	Do. do. 5 % Debs.	Stock	..	..	..	102 —105	100 —103 xd	..	..
15,609	West African Telegraph, Shares	10	..	..	..	3 — 4	3 — 4	..	..
30,008	West Coast of America, Nos. 1 to 30,000 and 53,001 to 53,008	2½	..	..	..	0 — ¼	0 — ¼	..	..
150,000£	Do. do. 4% Debs., 1 to 1,500 guar. by Braz. Sub. Tel.	100	..	..	..	98 —101	98 —101	..	..
267,980	Western Telegraph, Ltd., Nos. 1 to 267,980	10	7 %	7 %	7 %	11⅛— 11⅜xd.	11 — 11⅛	11⅛	11⅛
75,000£	Do. do. 5 % Debs. 2nd series, 1906	100	..	..	..	102 —105	100 —103 xd	..	..
400,000	Do. do. 4 % Deb. Stock Red.	100	..	..	..	99 —102	97 —100 xd	..	..
88,321	West India and Panama Telegraph	10	⅝%	½%	..	⅝— ¾	⅝— ¾	..	..
34,563	Do. do. do. 6 % Cum. 1st Pref.	10	..	..	..	4½— 5½	4½— 5½	5⅛	..
4,669	Do. do. do. 6 % Cum. 2nd Pref.	10	..	..	..	3 — 4	3 — 4	..	..
80,000£	Do. do. do. 5 % Debs., Nos. 1 to 1,800	100	..	..	..	100 —103	100 — 103	..	..

ELECTRICAL RAILWAY, MANUFACTURING AND INDUSTRIAL COMPANIES.

20,000	British Aluminium 7 % Cum. Pref.	10	..	5½%	..	3 — 4	3 — 4	..	..
800,000£	Do. do. 5 % 1st Mort. Deb. Stock Red.	Stock	..	..	..	75 — 80	75 — 80	..	..
100,000	British Electric Traction	10	8 %	9 %	9 %	12¾— 13¼	12¾— 13	13	..
100,000	Do. do. 6 % Cum. Pref.	10	..	..	..	11¾— 12¼	11¾— 12⅛	12	11⅞
600,000£	Do. do. 5 % Perpetual Debenture Stock	Stock	..	..	..	124 —127	124 —127	..	..
100,000	British Insulated Wire Ord.	5	20 %	15 %	10 %	7⅛— 8	7⅛— 8	..	..
100,000	Do. do. 6 % Cum. Pref.	5	..	..	..	5¾— 6	5¾— 6	..	..
50,000	Do. do. 4½ % 1st Mort. Deb. Red.	100	..	..	..	105 —108	103 —106 xd	..	..
50,000	¶Browett, Lindley & Co. (1899), Ord.	£1	..	8 %	..	12/6 to 13/6	12/6 to 13/6	..	..
50,000	¶ Do. do. 6 % Cum. Pref.	£1	..	6 %	..	16/6 to 17s.	16/6 to 17s.	..	..
105,731	Brush Electrical Engineering, Ord., 1 to 105,731	2	5½%	5 %	Nil	¾— 1⅛	¾— 1⅛	..	..
150,000	Do. do. Non-cum. 6 % Pref.	2	6 %	6 %	3 %	1 — 1⅛	1 — 1⅛	..	..
125,000£	Do. do. 4½ % Perp. Deb. Stock	Stock	..	..	..	100 —103	100 —103	..	..
125,000£	Do. do. 4½ % Perp. 2nd Deb. Stock	Stock	..	..	..	93 — 98	93 — 98	..	..
35,000	Callender's Cable Construction shares	5	15 %	15 %	20 %	14 — 15	14 — 15	..	..
40,000	Do. do. do. 5 % Cum. Pref.	5	..	..	..	5¾— 6	5¾— 6 xd	..	..
90,000£	Do. do. do. 4½ % 1st Mort. Deb. Stock Red.	Stock	..	..	..	109 —113	107 —110	109	107
1,860,014	Central London Railway, Ord. Stock	Stock	..	..	4 %	107 —110	105 —108	..	..
494,093	Do. do. 4 % Pref. Stock	Stock	..	..	4 %	105 —108	108 —111	..	..
494,993	Do. do. Def. do.	Stock	..	..	4 %	107 —110	106 —109	..	..
1,330,000	City and South London Railway	Stock	1⅝%	1½%	2 %	74½— 75½	75½— 76½	76½	76½
85,000	Crompton & Co., Nos. 1 to 85,000	3	7½%	8 %	7½%	2¾— 3	2¾— 3	..	..
100,000£	Do. 5 % 1st Mort. Reg. Debs., 1 to 900 of £100, and 901 to 11,000 of £50 red.	..	..	..	..	101 —106 %	101 —106 %	..	..
99,261	Edison & Swan United Elec. Light, "A" shares, £8 paid, 1 to 99,261	5	6 %	2½%	..	⅛— ¼	⅛— ¼	..	..
17,139	Do. do. "A" shares, 01—017,139	5	6 %	2½%	..	1⅞— 2⅛	1⅞— 2⅛	..	..
844,023£	Do. do. 4 % Deb. Stock Red.	100	..	..	..	74 — 78	74 — 78	..	..
100,000£	Do. do. 5 % 2nd Deb. Stock Prov. Certs. all pd.	100	..	..	..	77 — 82	77 — 82	..	..
112,100	Electric Construction, 1 to 112,100	2	6 %	6 %	6 %	1⅛— 1⅜	1⅛— 1⅜	..	..
31,390	Do. do. 7 % Cum. Pref., 1 to 31,390	2	..	..	..	2⅛— 2⅜	2⅛— 2⅜	..	..
182,500£	Do. do. 4 % Perp. 1st Mort. Deb. Stock	Stock	..	..	..	99 —102	99 —102	..	..
25,000	General Electric Co. (1900), 5 % Cum. Pref.	10	..	5 %	5 %	10 — 10½	10 — 10½ xd	..	..
200,000	Do. do. 4 % Mort. Deb.	Stock	..	..	..	99 —102	99 —102	..	..
35,000	Henley's (W. T.) Telegraph Works, Ord.	5	15 %	20 %	20 %	16½— 17⅛	16½— 17⅛	..	..
35,000	Do. do. 4½ % Pref.	5	4½%	4½%	..	5⅞— 6⅛	5⅞— 6⅛	..	..
48,050	Do. do. 4½ Mort. Deb. Stock	Stock	..	..	..	109 —113	109 —113	..	..
50,000	India-Rubber, Gutta-Percha & Telegraph Works	10	10 %	10 %	10 %	20½— 21½	20 — 21	..	..
300,000£	Do. do. do. 4 % 1st Mort. Deb.	100	..	..	..	100 —103	100 —103	..	..
37,500	†Liverpool Overhead Railway, Ord.	10	3½%	3½%	1½%	6¼— 6¾	5⅞— 6⅜	..	..
10,000	† Do. do. Pref. £10 paid	10	5 %	..	..	9¾— 10¼	9¾— 10¼	..	..
7,500	Parker (Thomas), Ltd., Ord., Nos. 1 to 7,500	10	..	..	..	14½— 15½	14½— 15½	..	..
	§Rosling & Fynn 6 % Cum. Pref.	£1	..	6 %	..	19/0 to 20/0	..	..	..
37,350	Telegraph Construction and Maintenance	12	15 %	17½%	20 %	37 — 40	37 — 40	..	..
150,000£	Do. do. 4 % Deb. Bds., Nos. 1 to 1,500 Red. 1909	100	..	..	..	102 —105	102 —105	..	..
540,000£	Waterloo & City Railway, Ord. Stock	100	3 %	3 %	3 %	94 — 96	94 — 97	96	95½

† Quotations on Liverpool Stock Exchange.
§ From Bradford Share List.
‡ Unless otherwise stated all shares are fully paid.
¶ From Manchester Share List.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Consolidated Telephone Construction and Maintenance, ⅛—⅜.
National Electric Free Wiring, ½—1.
Oldham, Ashton, and Hyde Electric (£10 pd.), Ord., 13—14.
Do. do. Pref. (£10 pd.), 10—11.

Bank rate of discount 4 per cent. (October 2nd, 1902).

SHARE LIST OF ELECTRICAL COMPANIES (*continued*).—ELECTRICITY SUPPLY COMPANIES.

Present issue.	NAME.	Stock or Share.	Dividends for the last three years. 1899.	1900.	1901.	Closing Quotations Dec. 22nd.	Closing Quotations Dec. 31st.	Business done week ended Dec. 31st, 1902. Highest.	Lowest.
100,000	Blackheath and Greenwich Dist. Electric Light, Ord.	‡ 1	..	..	..	⅜ — ⅝	⅜ — ⅝	..	..
100,000	Do. 4½% 1st Deb. Stock, Prov. Certs.	100	..	..	..	110 —113	110 —113	..	..
20,000	Brompton & Kensington Electric Light Sup., Ord., 1 to 20,000	5	6 %	6 %	8 %	9½ — 10½	10 — 10½	..	..
20,000	Do. do. 7 % Cum. Pref.	5	..	..	..	9½ — 10½	10 — 10½	..	..
50,000	Charing Cross and Strand Electricity Supply	5	9 %	9 %	10 %	9¼ — 9½	9¼ — 9⅜	9⅜	..
70,000	Do. do. do. 4½% Cum. Pref.	5	..	..	..	5⅛ — 5⅜	5⅛ — 5⅜	..	..
40,000	Do. do. "City Undertaking" 4½% Cum. Pref.	5	..	..	..	4⅞ — 5⅛	4⅞ — 5⅛ xd	..	..
250,000	Do. do. 4 % Deb. Stock Red.	100	..	..	..	103 —105	103 —105 xd	..	..
44,436	*Chelsea Electricity Supply, Ord.	5	6 %	5½%	4 %	5⅛ — 6	5⅛ — 5⅜	..	..
150,000‖	Do. do. % Deb. Stock Red.	Stock	..	..	..	110 —113	108 —111 xd	..	..
70,595	City of London Electric Lighting, Ord. 40,001—110,595	10	4 %	0 %	5 %	9½ — 10½	10½ — 11	10⅝	10⅜
40,000	Do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	..	13 — 14	13 — 14	..	..
400,000‖	Do. 5 % Deb. Stock, Scrip. (iss. at 115) all paid	..	..	..	..	124 —129	122 —12 xd	..	..
300,000	Do. 4½% 2nd Deb. Stock, Prov. Certs., all paid	100	..	..	..	104 —107	102 —105 xd	..	..
40,000	County of London & Brush Prov. Electric Lighting, Ord. 1—40,000	10	4 %	4 %	4 %	8½ — 9½	8½ — 9½	..	..
20,000	Do. do. do. 6 % Pref., 40,001—60,000	10	6 %	6 %	..	12 — 13	12 — 13	..	..
400,000‖	Do. do. 4½% Deb. Stock, Prov. Certs. (all paid) Red	..	..	..	..	109 —112	107 —110 xd	107⅛	..
50,000	Edmundson's Electric Corporation, Ord. Shares	5	6 %	7 %	7 %	6½ — 6¾	6½ — 6⅝	6 1/16	..
30,000	Do. do. 6 % Cum. Pref.	..	..	..	..	6 — 6½	6 — 6½	..	..
140,000	Do. do. 4½% 1st Mort. Deb. Stock	100	..	..	..	107 —110	107 —110	..	..
21,000	Kensington and Knightsbridge Electric, Ord.	5	11 %	12 %	10 %	10 — 11	10 — 11	..	..
90,000	Do. do. do. 4 % Debenture Stock	Stock	..	..	..	101 —104	101 —104	..	..
110,000	London Electric Supply Corporation, Limited, Ord.	3	..	..	..	1⅞ — 2⅛	1⅞ — 2⅛	..	..
49,840	Do. do. do. 6 % Pref.	5	..	..	..	5 — 5⅛	5 — 5⅛	..	..
250,000‖	Do. do. do. 4 % 1st Mort. Deb. Stock Red	Stock	..	..	..	96 — 98	96 — 99	97½	..
100,000	Metropolitan Electric Supply, 1 to 100,000	10	5 %	6 %	6½%	14 — 15	15⅛ — 16⅛	15⅝	..
220,000‖	Do. do. 4½% 1st Mort. Deb. Stock	..	..	..	..	109 —114	107 —112 xd	..	..
250,000‖	D. do. 3½% Mort. Deb. Stock Red	Stock	..	..	..	99 —102	99 —102	..	..
10,852	Notting Hill Electric Lighting	10	7 %	7 %	6 %	14⅛ — 15⅛	14⅛ — 15⅛	..	..
40,000	St. James' and Pall Mall Electric Light, Ord.	5	14⅛%	14⅛%	14⅛%	14⅛ — 15⅛	14⅛ — 15⅛	..	..
20,000	Do. do. do. 7 % Pref. 20,081 to 40,080	5	7 %	7 %	7 %	8¼ — 9¼	8¼ — 9¼	..	..
150,000‖	Do. do. do. 3½% Deb. Stock Red	100	..	..	..	98 —101	98 —101	..	..
12,000	Smithfield Markets Electric Supply, Ord.	5	..	..	..	1⅝ — 2⅛	1⅝ — 2⅛	..	..
50,000‖	Do. do. 4% Deb.	100	..	..	..	80 — 90	80 — 90	..	..
65,000	South London Electricity Supply, Ord.	5	..	..	..	3 — 3⅛	3 — 3⅛	3⅜	..
30,000	Urban Electric Supply, Ord., £4 pd.	5	..	..	..	3⅝ — 4⅛	3⅝ — 4⅛	..	..
30,000	Do. do. 5 % Cum. Pref., £4 pd.	5	..	..	..	3⅝ — 4⅛	3⅝ — 4⅛	..	..
110,000	Westminster Electric Supply, Ord.	5	13 %	10½%	10½%	11 — 12	11 — 12	11⅝	11 7/16
28,141	Do. do. 5 % Cum. Pref.	5	..	..	..	6 — 6¼	6 — 6¼	6⅜	..

* Subject to Founders Shares. ‡ Unless otherwise stated all shares are fully paid.

MARKET QUOTATIONS. Wednesday, December 31st.

CHEMICALS, &c.		Last week.	This week.	Inc. or Dec.
a Acid, Hydrochloric	per cwt.	5/-	5/-	..
a ,, Nitric	per cwt.	22/-	22/-	..
a ,, Oxalic	per cwt.	32/-	32/-	..
a ,, Sulphuric	per cwt.	5/6	5/6	..
a Ammoniac, Sal	per cwt.	42/-	42/-	..
a Ammonia, Muriate (crystal)	per ton	£33 10	£33 10	..
a ,, ,,	per ton	£30	£30	..
a Bleaching powder	per ton	£4 10	£4 10	..
a Bisulphide of Carbon	per ton	£15	£15	..
a Borax	per ton	£13	£13	..
a Benzole (90 %)	per gal.	7/-	7/-	..
a ,, (50/90 %)	per gal.	5/6	5/6	..
a Copper Sulphate	per ton	£17 10	£17 10	..
a Lead, Nitrate	per ton	£24	£24	..
a ,, White Sugar	per ton	£31	£31	..
a ,, Peroxide	per ton	£27 10	£27 10	..
a Methylated Spirit	per gal.	2/6	2/6	..
a Naphtha, Solvent (90% at 160° C).	per gal.	5/6	5/6	..
a Potash, Bichromate, in casks	per lb.	3d.	3d.	..
a ,, Caustic (75/80%)	per ton	£24	£24	..
a ,, Bisulphate	per ton	£35	£35	..
a Shellac	per cwt.	130/-	130/-	..
a Sulphate of Magnesia	per ton	£4 10	£4 10	..
a Sulphur, Sublimed Flowers	per ton	£6 5	£6 5	..
a ,, Recovered	per ton	£5 10	£5 10	..
a ,, Lump	per ton	£5	£5	..
a Soda, Caustic (white 70 %)	per ton	£10 15	£10 15	..
a ,, Crystals	per ton	£3	£3	..
a ,, Bichromate, casks	per lb.	2½d.	2½d.	..

METALS, &c.				
b Aluminium Ingots, in ton lots	per ton	£148	£148	..
b ,, Wire, in ton lots	per ton	£224	£224	..
b ,, Sheet, in ton lots	per ton	£191	£191	..
p Babbitt's metal ingots	per ton	£40 to £130	£40 to £130	..
c Brass (rolled metal 2' to 12') basis	per lb.	5¾d.	6¼d.	..
c ,, Tube (brazed)	per lb.	8¼d.	8¼d.	..
c ,, ,, (solid drawn)	per lb.	6¾d.	6¾d.	..
c ,, Wire, basis	per lb.	6¼d.	6¼d.	..
c Copper Tubes (brazed)	per lb.	8¾d.	8¾d.	..
c ,, ,, (solid drawn)	per lb.	9d.	9d.	..
g Copper Bars (best selected	per ton	£65	£65	..

METALS, &c. (*continued*).				
g Copper Sheet	per ton	£65	£65	..
g ,, Rod	per ton	£65	£65	..
e ,, (Electrolytic) Bars	per ton	£55	£55	..
e ,, ,, Sheets	per ton	£73	£73	..
e ,, ,, Rod	per ton	£61	£61	..
e ,, ,, H.C. Wire	per lb.	7d.	7d.	..
f Ebonite Rod	per lb.	3/-	3/-	..
f ,, Sheet	per lb.	5/-	5/-	..
n German Silver Wire	per lb.	1/4½	1/4½	..
h Gutta-percha fine	per lb.	8/-	8/-	..
h India-rubber, Para fine	per lb.	3/4½ to 3/7½	3/8 to 3/10	inc.
i Iron, Charcoal Sheets	per ton	£18	£18	..
i ,, Pig (Cleveland warrants)	per ton	47/6	47/6	..
i ,, Forgings, according to size	per ton	From £11	From £11	..
i ,, Scrap, heavy	per ton	47/6 to 50/-	47/6 to 50/-	..
i ,, Wire, galvanised No. 8	per ton	£9 15	£9 15	..
g Lead, English Ingot	per ton	£11 to £11 2 6	£11 to £11 5	inc.
g ,, ,, Sheet	per ton	£18	£18	..
m Manganin Wire No. 28	per lb.	8/-	8/-	..
g Mercury	per bot.	£8 15	£8 15	..
d Mica (in: ginal cases) small	per lb.	3d. to 9d.	3d. to 9d.	..
d ,, ,, ,, medium	per lb.	1/9 to 2/9	1/9 to 2/9	..
d ,, ,, ,, large	per lb.	3/3 to 7/3	3/3 to 7/3	..
p Phosphor Bronze, plain castings	per lb.	11½d. to 1/2	11½d. to 1/2	..
p ,, rolled bars & rods	per lb.	1/- to 1/3	1/- to 1/3	..
p ,, ,, strip & sheet	per lb.	From 1/2	From 1/2	..
o Platinum	per oz.	£4	£4	..
p Silicium Bronze Wire	per lb.	9d. to 1/-	9d. to 1/-	..
i Stee., Magnet, acc'd'g to desc'p'n	per ton	£58	£58	..
i ,, ,, in bars		From £15	to £40	..
g Tin, Block	per ton	£118 to £119	£121 to £122	£3 inc.
g ,, Foil	per lb.	1/6	1/6	..
n ,, Wire, Nos. 1 to 16	per lb.	1/6½	1/6½	..
p White Anti-friction Metals— "White Ant" brand	per ton	£36 to £60	£36 to £60	..
j Yarns, 2/10s Grey Cotton, on sp'ls	per lb.	7d.	7d.	..
j ,, 6 lea. Flax	per lb.	5¾d.	5¾d.	..
j ,, 3 ply 10 lbs. Russian	per lb.	4 13/16d.	4 13/16d.	..
j ,, 10 lbs. Russian, single	per lb.	4¾d.	4¾d.	..
j ,, 180 lbs. Jute rove	per ton	£11 11	£11 11	..
k Zinc, Sh't (Vieille Montagne bnd.)	per ton	£23	£23	..

Quotations supplied by { *a* Messrs. G. Boor & Co. *b* The British Aluminium Co., Ltd. *c* Messrs. Thos. Bolton & Sons., Ltd. *d* Messrs. F. Wiggins & Sons. *e* Messrs. Frederick Smith & Co.

Quotations supplied by { *f* India-Rubber, G.P. and Teleg. Works *g* Messrs. James & Shakspeare. [Co., Ltd. *h* Messrs. Edward Till & Co. *i* Messrs. Bolling & Lowe. *j* Messrs. Walter H. Hindley & Co., Ltd.

Quotations supplied by { *k* Messrs. Morris Ashby, Limited. *m* Messrs. W. T. Glover & Co., Ltd. *n* Messrs. P. Ormiston & Sons. *o* Messrs. Johnson, Matthey & Co., Ltd. *p* The Phosphor Bronze Company Ltd.

TRAFFIC RECEIPTS.

Company.	Week ending	Receipts for the week. Am'nt.	Inc. or dec.*	Total to date. Am'nt.	Inc. or dec.*	Miles open. This year.	Last year.
Blackburn Corp. Trys.	Dec. 26	£ 886	£ +150	£ 32,278	£ + 4,135	12½	12½
Blackpool and Fleetwood	,, 27	2 7	+ 67	20,856	— 98	7¼	7 7/16
Bristol Trys. & Car. Co.	,, 26	5,314	+734	—	—	28	28
British Elec. Trac. Co.:—							
Barnsley	,, 19	151	—	252	—	—	—
Devonport	,, 19	378	— 7	21,578	+ 1,169	5	5
Dudley—Stourbridge	,, 19	696	+126	28 408	+ 4,736	18½	18½
Gateshead	,, 19	625	+319	20,776	+ 7,962	10½	9¾
Gravesend—Northfleet	,, 19	155	—	3,9 8	—	2½	—
Greenock—Pt. Glasgow	,, 19	261	+ 64	25 093	+13,455	7¼	7¼
Hartlepool	,, 19	207	+ 50	12,552	+ 1,207	6½	4½
Kidderminster	,, 19	92	— 1	6,175	+ 60	4¼	4¼
Maryport	,, 19	103	— 8	9,948	— 1,779	5	5
Middleton	,, 19	204	—	11,007	—	8½	—
Oldham—Ashton	,, 19	493	+ 57	26,850	+ 1,698	8	8
Poole	,, 19	197	+ 25	12,808	+ 35	3½	3½
Potteries	,, 19	1,553	+216	76,347	+ 5,126	28½	28½
Rotherham	,, 19	33	+ 14	1,951	+ 451	—	—
B.E.T. Co. (*continued*)—							
Southport	Dec. 19	204	+ 92	12,916	+ 4,754	5½	5½
South Staffordshire	,, 19	625	— 48	37,661	— 1,591	21½	22½
Swansea	,, 19	444	+ 89	23,857	+ 1,559	5½	5½
Taunton	,, 19	47	— 0	3 207	— 361	1½	—
Tynemouth	,, 19	199	+ 89	14,663	+ 2,195	3½	3½
Weston-super-Mare	,, 17	23	—	5,561	—	2½	—
Wolverhampton Dist.	,, 19	336	+238	11,374	+ 7,429	10½	9½
Central London Railway	,, 27	6,135	+206	173,'04	+12,269	6	6
City and S. London Ry.	,, 28	3,143	+ 40	80,997	+29,328	6½	6½
Doncaster Corp. Trys.	—	—	—	—	—	5½	—
Dover Corporation Trys.	,, 27	204	+ 33	11,193	+ 62	3	3
Dublin United Trys.	,, 26	5,020	+527	123,185	+ 3,578	46	46
East Ham Tramways	,, 27	586	+237	13,569	+ 3,044	5	4½
Glasgow Corp. Trys.	,, 20	11,972	+1 763	354,833	+ 3,862	62	50½
Liverpool Overhead Ry.	,, 28	1,411	+171	40,079	— 325	6½	6½
Newcastle Corp. Trys.	,, 27	8,406	—	—	—	35	—
Sunderland Corp. Trys.	,, 28	1,240	+ 77	—	—	17½	17½

* Compared with the corresponding period of 1901.

ELECTRICITY ON BOARD SHIPS.

AT the general meeting of the Society of Naval Architects and Marine Engineers, held in New York in November, Mr. F. O. Blackwell read a paper on "Probable Future Developments in the Use of Electricity on Board Ships," which is fully abstracted in the *Electrical World and Engineer*. He treated the subjects with respect to the substitution of steam turbines for reciprocating engines for driving the electric generators, the use of alternating-current generators and motors instead of continuous-current apparatus, and the operation of all auxiliary machinery on ships by electric motors.

Mr. Blackwell considers that the steam turbine is ideal for the driving of electric generators. Within reasonable limits, the higher the speed of electrical apparatus the smaller, lighter, and more efficient it becomes, and we may even consider the electric motor and generator simply as a convenient speed-reducing and distributing mechanism, which is more efficient than most mechanical connections. Compared with the reciprocating engines and slow-speed generators now used in our Navy, a turbine plant can be designed which will have but one-quarter the weight, and take but one-tenth the space. It might also save weight in the structure of the ship, on account of its lightness and freedom from vibration.

The steam turbine can be used with a high degree of superheat (when superheated steam comes into general marine use, as it undoubtedly will before long), because there are no lubricated surfaces in contact with the steam, and a high vacuum can be obtained because there are no piston-rod packings to leak air. The entire absence of lubricating oil in the condensed steam is also a great advantage to avoid deterioration and foaming in boilers. The efficiency is very high, especially when we consider that it is the actual efficiency, including all mechanical and electrical losses, there being no such thing as indicated horse-power in a turbine.

The steam consumption of, let us say, a 300-KW. turbo-alternator at full load with dry steam at 200 lbs. pressure and 28-in. vacuum would be about 20 lbs. of steam per KW.-hour, or 15 lbs. per electrical H.P.-hour. The steam consumption at ½ load would be about 22 lbs. per KW.-hour. There is no objection, therefore, to putting in large units and running them much of the time underloaded. In order to appreciate this, it should be contrasted with some present reciprocating compound dynamo engines, which take 30 to 50 lbs. of steam per KW.-hour at full load, and 40 to 65 lbs. at ½ load. It is claimed to be at least as efficient as the main engines at full load, and much better than they are at cruising speed. It should not be forgotten that the average ship dynamo and engine now in use is of from 30 to 100 KW capacity, and also that the high speed alternator has a higher efficiency than the slow speed continuous-current generator, especially at low potentials, when the commutator brush friction is high. The steam turbine can be used to drive continuous-current generators, but not to as good advantage as an alternator on account of the high speed.

After a comparison of the continuous and alternating current systems, Mr. Blackwell says that the polyphase (that is, two and three-phase) system permits the design of a cheaper and lighter generator and motor, and is therefore particularly applicable to operate motors. In addition, it gives a motor which will start with full torque, whereas the single-phase, like a single-crank engine, becomes dead-centred at starting, unless somewhat complicated starting devices are employed.

As between the two-phase and three-phase systems, the two-phase requires four wires and the three-phase but three. One-third more copper is required for either one-phase or two-phase than is needed for three-phase under the same conditions. It is evident, therefore, that to supply power to motors the three-phase system is more economical, while for incandescent lamps one-phase is preferable in order to make the lamp wiring as simple as possible. Fortunately, we can combine these two methods of distribution and get the advantages of both

The lighting should only be a small portion of the entire load of a ship-power plant, and any one three-phase generator can carry it all single-phase without difficulty. The potential supplied for lighting must be perfectly constant in order to give good service and not burn out the lamps. The motors run practically as well with a variable as with a constant voltage. The alternator should therefore be made with a regulating device that automatically gives constant potential to the one-phase lighting circuit, even if the other branches of the three-phase circuit vary.

It is also an advantage of alternating-current machinery that there is no magnetic field set up by the generators, motors, or by the constantly reversing currents in the wiring that can affect the ship's compass. Neither does alternating current cause electrolytic action should it pass through the iron work of the vessel.

After outlining the principles of alternating-current generators, and stating that the synchronous motor is unfitted for shipboard work, the induction motor is described. It is pointed out that the speed of the motor is determined by the periodicity of the system, and the number of poles for which it is wound. At no-load it runs at synchronous speed, but under load it ordinarily drops off 2 or 3 per cent. If the motor is driven above synchronous speed, it becomes a generator, and returns power to the system. Varying the potential within ordinary limits does not affect the speed of the motor.

The torque is limited. Usually the maximum either at starting or full speed is between two and three times the full-load torque, and if loaded beyond this point it stops. The maximum torque varies as the square of the potential, and can be increased for intermittent work by raising the potential. In order to reduce the speed below synchronism, power must be wasted in resistance. To get full torque at starting requires at least full-load current. Induction motors cause a lag in the current wave behind the potential wave, which at full load increases the current about 10 per cent., without increasing the actual power consumed. The ratio of the actual to the apparent power is called the power factor of the motor.

In the continuous-current, shunt-wound motor, the speed can be changed by varying the strength of the field current within certain limits and with nearly constant efficiency, as is now done with blower motors. In the series continuous-current motor the speed automatically varies with the load (a heavy load giving a slow speed and a light load a high speed) as in most of the hoist motors at present used. A continuous-current motor may also be operated efficiently at any speed by varying the potential supplied to the motor, as, for example, the present type of electric turret control. The induction motor will not permit of any of these forms of control, and other less efficient methods must be substituted.

There are two forms of revolving secondaries, or armatures, in use in induction motors. In one the winding consists of bars all joined together at the heads, and is known as the squirrel-cage or short-circuited armature. In the other the secondary is polar-wound, and the ends of the winding are connected to a variable resistance, either inside the armature or external to it.

In order to vary the speed two methods are used. The polar-winding can be connected to collector rings, so that the current in the secondary is carried to a controller which cuts in more or less resistance. This is known as secondary control. A short-circuited secondary may be used of permanent high resistance. By varying the potential supplied to the motor, the current flowing in the secondary is increased or diminished, and this acting over the fixed resistance changes the speed of the motor. The former method is preferable, as it is more efficient, and the power does not go into heating the motor and reducing its capacity, but is dissipated externally. The latter method, however, has the advantage of having only one set of wires carried to the motor, and is, therefore, superior for distant control.

The windings of an induction motor can be connected so as to give two or more speeds by changing from, say, four to eight poles. With a short-circuited secondary this requires no change in the armature. The speed may also be varied by changing the periodicity of the system. A combination of these two methods has been employed to give a considerable number of speeds, at each of which the motor runs with full efficiency. The weight of induction and continuous current motors is for ordinary speeds about the same. At high speeds the alternating motor is lighter, while at slow speed it is heavier on account of the large number of poles and greater diameter required.

For shipboard service the choice of periodicity lies between 30 and 40 cycles, with a preference for 40 cycles, which gives a higher maximum speed and a rather better range of speeds. It is also the lowest periodicity that can be used for arc lighting, which will probably be more used than it has been in the past.

In transmitting power by alternating currents, in addition to the loss due to the resistance of the conductors, there is an apparent loss of energy and an actual drop of potential caused by the inductance of the wires. The inductive drop is unimportant with small conductors, as used for lighting, but may be considerable with the large conductors and currents required for motors. The inductive loss may also be greatly increased if single wires are enclosed in iron tubes or run near iron work.

If a complete circuit, that is, two wires for one-phase or three wires for three-phase, are placed together, the inductance is practically negligible. By using double-conductor cable for single-phase and triple-conductor for three-phase, alternating current may be run through iron pipes or along iron-work without difficulty The single-phase wiring for lighting will be nearly the same, therefore, as for continuous current.

The power circuits constitute over nine-tenths of the load, and must therefore be given careful thought. By employing three-phase current a saving of 25 per cent. is effected in conductors as compared with continuous current at the same potential. By increasing the power-circuit pressure to 220 volts, a further saving of copper is made. Two hundred and twenty volts requires but one-third the weight of conductors needed for 125 volts.

The wattless current of induction motors will reduce the economy somewhat, but we can safely say that a 220-volt three-phase system can be operated with but one-third the copper of a continuous current, 125-volt, other things being equal. Comparing this alternating system with the existing 80-volt, continuous current, the copper required will be but one-sixth; in other words, the wiring for a 1,200-KW. three-phase system will be no greater than that of a 200-KW. continuous current.

Driving all auxiliaries, including the feed, circulating and air pumps, by motors is more efficient and has many advantages over steam operation. It is argued that because the exhaust from the auxiliaries is turned into the feed-water heaters and distilling apparatus, it makes no difference how much steam is consumed by them. This is true to a certain extent, but the energy lost by leakage and radiation in the piping and cylinders cannot be recovered. The hot steam pipes to the auxiliaries are most objectionable in themselves, and a source of constant trouble in service. The auxiliaries are much less efficient when they are operated only occasionally or at less than their full capacity when the ship is running at cruising speed or in port. The mechanical efficiency of the small engines is also very poor.

Auxiliaries which take from 50 to 300 lbs. of steam per horse-power hour and have to be run by throttling the steam down to a fraction of the boiler pressure, as is often the case now, are so

inefficient that the system is little better than heating the feed-water by steam directly from the boiler, which is evidently a poorer method than heating the feed-water in the boiler itself. The proper way is to get as much mechanical power as possible out of the steam before it is turned into the heater and its latent heat given up to the feed-water passing into the boilers. When the auxiliaries average 150 lbs. of steam per indicated horse-power-hour, as they did on the United States ss. *Minneapolis*, it means that 1½ per cent. of the heat energy of the steam is converted into mechanical power.

By taking steam from the main engines after it has partially expanded, a return of from 8 per cent. to 10 per cent. of the heat energy may be obtained in mechanical power. A pound of coal may only be worth $\frac{1}{10}$ of a cent., but the mechanical equivalent of its heat value, 5 H.P.-hours, may be worth 5 cents, or fifty times as much. Steam for the feed-water heaters, distillers, evaporators, and steam-heating should be taken from between the low and the intermediate cylinders of the main engine, or when that is shut down from some intermediate stage of the turbine wheels of the electric plant.

By using motor-driven auxiliaries, the oil which is introduced into the feed-water by reciprocating engines is also done away with and the resulting troubles with boilers are avoided. The combined mechanical and electrical losses in the generator, motor and electrical transmission can be less than 20 per cent. With a steam economy in the turbo-alternator of 15 lbs. per horse-power-hour, this gives a steam consumption for the motor-driven auxiliary of 18 lbs., or about ⅓ that of the Minneapolis auxiliaries already referred to.

In order to have a basis for figuring, Mr. Blackwell assumed that the United States men-of-war *Connecticut* and *Louisiana* will be equipped with steam turbines and alternating apparatus for driving all the auxiliaries. These battleships, now being built at the Brooklyn Navy Yard and at Newport News, are to have a trial displacement of 16,000 tons, a speed of 18 knots, and main engines of 16,500 H.P.

The specifications of the Navy Department do not call for motors to drive the pumps, forced-draught blowers, ash hoists, anchor windlass or steering engine. The following table has been prepared to show what would be the running conditions were all machinery except the propelling engines driven by motors. The number and size of some of the auxiliaries have been changed to meet the needs of electric driving. In some cases the powers have had to be assumed, no data being at hand, and the list is only an approximate estimate to get at the total power needed under maximum and ordinary conditions. The maximum load is taken to be when the ship is going into action at full speed.

PROPOSED MOTOR EQUIPMENT OF U.S. BATTLESHIPS *Connecticut* AND *Louisiana*.

Motors for—	No.	Total rated H.P.	Average max. H.P., full speed in action.	Ordinary H.P., cruising speed.	Port H.P.
Blowers, ventilating ...	41	87	75	75	75
Blowers, forced draught ...	12	204	204	0	0
Hoists, ammunition ...	32	274	100	100	100
Hoists, ash	6	48	12	12	12
Boat cranes	4	160	0	0	80
Deck winches	6	180	0	0	25
Windlass, anchor	1	300	0	0	0
Turret turning	12	220	40	0	0
Elevating guns	12	25	5	0	0
Rammers	12	48	5	0	0
Foundry and workshop ...	2	25	0	25	25
Ammunition conveyors ...	4	20	13	0	0
Doors and hatches	47	25	0	0	0
Steering	1	100	20	10	0
Ice machine...	1	25	15	15	15
Pumps, fresh water... ...	2	10	5	5	5
„ flushing	2	10	5	5	5
„ main feed	4	200	100	25	0
„ main air	2	50	25	7	0
„ circulating	2	200	50	13	0
„ auxiliary feed ...	4	20	10	5	5
„ „ air ...	2	5	3	2	2
„ „ circ. ...	2	10	5	5	5
„ fire, bilge, shaft, &c.	6	100	10	10	10
„ distiller, evaporator and miscellaneous	8	25	5	5	5
Total motors	227	2,371	707	319	369
Incandescent lamps ...	1,200	60	30	30	30
Searlights	6	30	30	0	0
Total power	—	2,461	767	349	399

The specifications for the *Connecticut* and *Louisiana* now call for two separate power plants, each containing four 100-KW. generating sets. In order to take care of the other auxiliaries which the specifications did not contemplate operating by electric power, a larger plant is required, and at the same time larger and fewer units can be used, which is permissible because of the high steam economy of the turbine on partial loads.

The total nominal capacity of all the auxiliary apparatus is seen from the table to be about 2,500 H.P. Of this not more than 800 H.P. could possibly be in full operation at one time even when in action and going at full speed, and not more than 400 H.P. under ordinary cruising conditions or in port, not including the anchor windlass.

(To be concluded.)

THE AIMS OF LIGHTING ENGINEERING.

A VERY long illustrated lecture was given at a conversazione of the Berlin Electrical Society a few months ago by Herr Lummer, an abstract of which from the *Elek. Zeit.* recently appeared in the excellent digest of the *Electrical World and Engineer*, on "The Aims of Lighting Engineering." After a historical introduction, he discussed the measurements of light: the Bunsen and the Lummer-Brodhun photometers, the Hefner unit of light, and gave in a table the following series of the photometric economy of the usual sources of light, the figures representing the price in cents per Hefner candle-hour, based on the average prices in Berlin:—Incandescent gas light, 0.65; Bremer arc light, 0.5 to 0.75; arc light without globe, 1.25; acetylene incandescent light, 1.5; kerosene, 1.75; arc light with globe, 1.75; Nernst lamp, 2·5; ordinary electric incandescent lamps, 3.5 to 5.0; acetylene, 3.75; argand burner gas light, 3.25; bats-wing burner gas light, 5.25. He then discussed the nature of the different sources of light: luminescence and lighting due to heating. He then dealt with the physical principles of light and heat radiation, proved the existence of invisible heat rays, and discussed the separation of heat and light rays by absorption of the heat rays in water, &c. He distinguished between red heat and grey heat (just before red heat) and analysed the physiological phenomena. He discussed Kirchoff's law of absorption and emission of light, and spoke at length on the absolutely black body and its realisation in practice; he discussed the distribution of the energy in the spectrum of the black body, the laws of radiation of bright platinum, the laws referring to the energy maximum and the formula for the distribution of energy. He showed how these formulas can be used to determine the temperature of a black body from its radiation. With the use of such theories the temperature of lights can be determined, or at least given within limits: arc lamp between 4,200 and 3,750° C., Nernst lamp 2,450 to 2,200, Welsbach light 2,450 to 2,200, ordinary incandescent electric light 2,100 to 1,875, candle 1,960 to 1,750, argand lamp 1,900 to 1,700. The temperature of the sun and of fixed stars has also been determined, that of the sun is about 6,000°. Some of the fixed stars have a temperature higher than that of the sun by several thousand degrees. He remarked that the present art in lighting is still far from the ultimate in the production of light without heat. He then discussed the dependency of the illumination upon the temperature. The total radiation is proportional to the fourth power of the absolute temperature, the product of the absolute temperature and of the wave length at which the energy has a maximum, is constant; the maximum energy is proportional to the fifth power of the temperature, while the energy physiologically felt as light increases still more quickly with the temperature. In the yellow part of the spectrum the illumination is doubled if the temperature of the black body is increased from 1,800° to 1,875°, *i.e.*, by about 4 per cent. Concerning the total illumination, Herr Lummer states that if the temperature is increased from 2,000° to 4,000° C., *i.e.*, in the ratio 1 to 2, the illumination is increased in the ratio 1 to 4,000; the carbon in arc lamps has a temperature of 4,000°, the filament of an incandescent lamp 2,000°; hence the arc lamp emits per unit of surface about 4,000 times more light than the incandescent lamp. The sun, which glows at 6,000°, emits 600,000 times the illumination per unit of surface of the incandescent lamp. The aim of the light engineers should be to find substances which can be heated up to 6,000° without being destroyed, as at this temperature the energy maximum is within the visible spectrum at the part where our eye is most sensitive. Three over-run incandescent lamps, each of 300-hours' life, are more economical than one normally burning lamp of 1,000 hours' life. In practice a similar thing is often done, by using 105 or 100-volt lamps in 110-volt installations. This use should be made a principle. The larger sale of lamps of limited life would tend to reduce the selling price. The advantages of the Nernst lamp are due to its elevated temperature. Concerning the temperature of the osmium lamp, nothing definite is yet known. The highest temperature on the earth is in the arc lamp. The introduction of suitable salts in the electric arc is a distinct progression, because more favourable substances are used for producing the light. The vapours of the lithium and strontium salts heated in the arc to enormous temperatures do not emit a continuous spectrum, but mainly coloured light. These arc lamps become similar to the Geissler tubes, in which the gas in the dilute state is excited to light emission by electro-luminescence. These newest arc lamps represent a connecting link between the light due to heat and that due to the luminescence of coloured vapours. The mercury vapour lamp seems to be a pure luminescence lamp. If this is so, the light would be entirely due to free vibrations of electrons, while in the ordinary sources of light there are forced oscillations of the electrons, caused by the molecular movement, due to heat. The paper contained a very large amount of information, and in an appendix was given a long list of references to publications and papers on this subject.

INSTITUTION OF ELECTRICAL ENGINEERS.

ON ELECTRONS.

By SIR OLIVER LODGE, F.R.S., Vice-President.

(Paper read in London, November 27th, 1902.)

(Continued from page 1045.)

APPENDICES TO PART I.

APPENDIX A.

Calculation of the Inertia of an Electric Charge.

LET a spherical conductor of radius a carrying a charge of electricity e move forward with moderate speed u; meaning by moderate speed anything distinctly less than the speed of light; it constitutes a current element of magnitude $e\,u$, and its circuit is closed by displacement currents in the surrounding dielectric; for its lines of force arise in the medium in front and subside in the medium behind, and so a displacement of electricity takes place from fore to aft to compensate the motion forward, and the lines of displacement are identical with the magnetic lines due to a short magnet. A charge may be said to travel carrying its electrostatic lines with it, or it may be said to be constantly generating a radial electrostatic field in front and destroying one behind. When an electric field thus moves partly laterally it generates a magnetic field—in the present instance in circular lines round the line of motion—for the moving charge is an element of a linear current.

The generation of these magnetic lines acts so as to oppose the current which produced them, but so long as they continue steady they exert no effect on it. When they subside, however, they tend to prolong the current which maintained them. Consequently, if the moving charge (or current) tries to stop, its retardation meets with obstruction; it is constrained to persist by the subsidence of the magnetic field which its motion excited and maintains. Its velocity is not resisted, there is nothing equivalent to friction, but its acceleration + or − is obstructed, an effect precisely analogous to inertia. If it is at rest it will need force to start it, and if it is in motion its motion will persist.

The charge acts, therefore, as if it had inertia, and we can proceed to calculate its amount.

While moving, it is a current and will be surrounded by rings of magnetic force, whose intensity, at any point with polar co-ordinates $r\,\theta$ referred to the line of motion as axis and the moving charge as origin, will be the quite ordinary expression (with $e\,u$ for the current element instead of $C\,ds$)—

$$H = \frac{e\,u \sin\theta}{r^2}.$$

The ordinary expression for the electrostatic force at the same point is—

$$E = \frac{e}{K\,r^2};$$

and if the motion is slow this value will be preserved, but if it is rapid the electric field gets weaker along the axis and stronger equatorially, having been shown by Mr. Heaviside (*Philosophical Magazine*, April, 1889), to be given by the following expression—

$$E = \frac{e}{K\,r^2} \cdot \frac{1 - (u/v)^2}{\{1 - (u \sin\theta/v)^2\}^{\frac{3}{2}}},$$

where v is the velocity of light.

The strength of the magnetic field will be similarly modified in this case; but the simplest mode of stating it is to express it in terms of E, and to say that *always*—

$$H = K\,E\,u \sin\theta.$$

The rate of transmission of energy will be the vector product of E and H; and the whole magnetic energy, that is the whole energy due to the current, *i.e.*, due to the motion, will be obtained by integrating the ordinary expression $\mu\,H^2/8\,\pi$ all over space outside the charged sphere, viz., from a to ∞ all round. In the general case this expression is a little long, but in the most important case, when the speed of motion u is decidedly less than the speed of light v, it is quite simple, and the working may as well be given:

Kinetic energy

$$= \int_a^\infty \frac{\mu\,H^2}{8\,\pi}\,d\,(\text{vol.}) = \frac{\mu\,e^2\,u^2}{8\,\pi} \int_0^\pi \int_0^{2\pi} \int_a^\infty \frac{\sin^2\theta}{r^4}\,dr \,.\, r\,d\theta \,.\, r\sin\theta\,d\phi$$

$$= \frac{\mu\,e^2\,u^2}{8} \int_0^{2\pi} \int_a^\infty \frac{\cos^2\theta - 1}{r^2}\,dr \,.\, d\cos\theta = \frac{\mu\,e^2\,u^2}{3\,a}.$$

Comparing this with mechanical kinetic energy $\frac{1}{2}\,m\,u^2$, we see that the charge on the sphere confers upon it additional kinetic energy, as if its mass were increased on account of the charge by the amount—

$$m = \frac{2\,\mu\,e^2}{3\,a},$$

which may also be written—

$$m = \frac{2\,\mu\,K \,.\, e^2}{3 \quad K\,a} = \frac{2}{3\,v^2} \,.\, e \,.\, \frac{e}{K\,a} = \frac{2}{3\,v^2} \times \text{charge} \times$$

potential, or—

$$\tfrac{2}{3}\,m\,v^2 = \text{the electrostatic energy of the charge.}$$

In other words, the mass equivalent to the charge is such that if it were a piece of matter with constant inertia travelling with the speed of light, its kinetic energy would be half as great again as the potential energy of the electric charge when standing still.

APPENDIX B.

The Electric Field due to a Moving Magnet.

If a short bar magnet or uniformly magnetised sphere (its moment M being the intensity of magnetisation × the volume of the sphere) moves along axially, that is in the direction of its magnetisation, with velocity u, it generates circular lines of electric force all centred upon its axis, much as a moving charge generates circular lines of magnetic force. If there is a conducting path around any such circle, then the motion of a magnet along its axis will generate a current in it, but if there be no conductor the motion will only result in an electric displacement which subsides when the magnet stops.

The intensity of the magnetic field at any point along the axis is well known to be $2\,M/r^3$; at any point on its equatorial plane it is $-\,M/r^3$; and in any intermediate direction it is, as regards magnitude alone—

$$H = \frac{M}{r^3}\sqrt{(1 + 3\cos^2\theta)}.$$

All this holds for the moving as for the stationary magnet, provided its speed does not approach that of light.

The electric force at the same point is—

$$E = \frac{3\,M\,u}{2\quad r^3} \sin 2\,\theta$$

$$= 3\,H\,u\,\frac{\sin\theta}{\sqrt{(4 + \tan^2\theta)}}.$$

The electrostatic energy resulting will be the integral of $K\,H^2/8\,\pi$ everywhere outside the moving magnetised sphere of radius a, viz.—Energy

$$= \frac{K}{8\,\pi} \int\int\int \left(\frac{3\,M\,u}{r^3}\right)^2 \sin^2\theta\cos^2\theta\,dr \,.\, r\,d\theta \,.\, r\sin\theta\,d\phi$$

$$= \frac{K\,M^2\,u^2}{5\,a^3} = \frac{M^2}{5\,\mu\,a^3}\left(\frac{u}{v}\right)^2.$$

The displacement acts like an elastic strain set up in the dielectric, storing the above energy statically; and so long as the magnet continues moving steadily the electric displacement exerts no force upon it; but acceleration will be resisted. If the magnet begins to go faster it sets up more displacement, and the act of setting this up constitutes a transient current which opposes the motion, as long as the acceleration continues, but it dies out the instant the motion becomes steady again.

Conversely, if the motion of the magnet began to slacken, the electric strain would begin to subside, and its subsidence would constitute an inverse transient current which would assist the motion, *i.e.*, oppose the slackening. In other words, the variations of the circular electric strain in the surrounding medium confer upon a moving magnet a spurious or apparent momentum, in addition to its real mechanical momentum: and thus the elastic strain itself may be said to represent a spurious or apparent inertia due to magnetisation, in addition to any real mechanical inertia which the body holding the magnetism may itself possess. And the amount of this extra inertia is—

$$m = \frac{2\,K\,M^2}{5\,a^5} = \frac{2\,M^2}{5\,\mu\,a^3\,v^2} = \frac{8}{15} \,.\, \frac{\pi\,I\,M}{\mu\,v^2}$$

$$= \frac{2}{5} \,.\, \frac{H_0\,M}{v^2},$$

where I is the intensity of magnetisation and H_0 the intensity of the field inside the substance of a uniformly magnetised sphere of radius a and magnetic moment M.

The equivalent mass moving with the velocity of light would therefore have an energy equal to one-fifth of the potential energy of the magnetised sphere if it were held at right angles to a field of its own internal intensity.

This result may be applied, *mutatis mutandis*, to a moving molecule consisting of a pair of equal opposite electrons not in absolute coincidence.

PART II.—DISCOVERY OF THE ATOM OF ELECTRICITY.

QUOTING again from the great Treatise of Clerk Maxwell, 1st edition, we find on page 312, in the chapter on electrolysis, the following sentence:—

"Suppose, however, that we leap over this difficulty by simply asserting the fact of the constant value of the molecular charge, and that we call this constant molecular charge, for convenience in description, one molecule of electricity."

Thus some idea of the conception of the atomic nature of electricity was forced upon men of genius by the facts of electrolysis and a knowledge of Faraday's laws. But Maxwell went on, after a few more paragraphs:—

"It is extremely improbable that when we come to understand the true nature of electrolysis we shall retain in any form the theory of molecular charges, for then we shall have obtained a

secure basis on which to form a true theory of electric currents, and so become independent of these provisional theories."

It is rash to predict what may ultimately happen, but the present state of electrical science seems hostile to this latter prediction of Maxwell. The theory of molecular charges looms bigger to-day, and has taken on a definiteness that would have surprised him.

The unit electric charge, the charge of a monad atom in electrolysis, whatever else it is, is a natural unit of electricity, of which we can have multiples, but of which, so far as we know at present, it is impossible to have fractions.

I will extract the following sentence from Section 32 of "Modern Views of Electricity":—

"This quantity, the charge of one monad atom, constitutes the smallest known portion of electricity, and is a real natural unit. Obviously this is a most vital fact. This unit, below which nothing is known, has even been styled an 'atom of electricity,' and perhaps the phrase may have some meaning. . . . This natural unit of electricity is exceedingly small, being about the hundred-thousand-millionth part of the ordinary electrostatic unit, or less than the hundred-trillionth of a coulomb."

The atom with its charge is called an ion. The charge considered alone, without its atom, was called by Dr. Johnstone Stoney an electron or natural electrical unit.

What we learn with great accuracy from electrolysis is the ratio of the charge to the mass of substance with which it is associated. It matters nothing how much substance is chosen, whether 100 atoms or one, whether an atom, or a gramme, or a ton, the amount of electricity associated with it in electrolysis and liberated when the substance is decomposed, increases in the same proportion; the ratio is constant, and if determined for one substance is known for all.

This is the ratio which is technically known as the electro-chemical equivalent of the substance. In the light of Faraday's laws, if this quantity is measured for one substance it is known for all, because the charge is the same for every kind of atom up to a simple multiple; and hence in specifying electro-chemical equivalents there is nothing to consider but the atomic weight or combining proportion of the substance. Thus the electro-chemical equivalent of oxygen is 8 times that of hydrogen, that of zinc is 32½ times, and that of silver 108 times that of hydrogen. The substance chosen for a determination of the electro-chemical equivalent, may be the one which can be most accurately experimented on, and Lord Rayleigh has shown that such a substance is nitrate of silver, and has ascertained that if a current of 1 ampere is passed from a silver anode to a platinum cathode through a nitrate of silver solution, the cathode gains in weight 4·025 grammes every hour. Hence the electro-chemical equivalent of silver is

$$\frac{4{\cdot}025 \text{ grammes}}{1 \text{ ampere-hour}};$$

the electro-chemical equivalent of hydrogen, being $\frac{1}{108}$ of this quantity, is—

$$\frac{4{\cdot}025 \text{ grammes}}{108 \text{ ampere-hours}} = \frac{4{\cdot}025}{108 \times 360} \text{ c.g.s.} = {\cdot}0001035 \text{ c.g.s.}$$

$$= \frac{1}{9{,}660} \text{ grammes per coulomb.}$$

Hence the ratio of an atom of electricity to an atom of hydrogen is

$$9{,}660\,\mu^{-\frac{1}{2}} \text{ c.g.s. units, or approximately } 10^4 \sqrt{\left(\frac{\text{centimetres}}{\mu \text{ grammes}}\right)};$$

the unknown constant μ necessarily making its appearance because we are comparing quantities measured in different ways, viz., Electricity and Matter (see Appendix D.).

The numerical part of this quantity is known with comparative exactitude,* that is to say, up to the limits of error of experiment. To proceed further, we must make an estimate of the mass of an atom; that can be done, and has been done, in many ways, and we have been taught both by Dr. Johnstone Stoney and by Loschmidt, and notably by Lord Kelvin, that the mass of an atom of water is approximately 10^{-24} of a gramme, wherefore an atom of hydrogen will be approximately 10^{-25} gramme; whence the unit of electric charge is 10^{-21} c.g.s. magnetic unit, or 10^{-10} of an electrostatic unit or 10^{-20} of a coulomb.

I have emphasised this matter of the ratio m to e or e to m because it plays a considerable part in what follows. The absolute values are of less consequence to us than the ratio, and are only known approximately, but the ratio is known with fair accuracy, and the ratio for hydrogen is very nearly 10^4 magnetic units, or more exactly 9,660.

Thus what we learn from electrolytic conduction briefly summarised is that every atom carries a certain definite charge or electric unit, monads carrying one, diads two, triads three, but never a fraction; that in liquids these charges are definitely associated with the atoms, and can only be torn away from them at the electrodes; that the current consists of a procession of such charges travelling with the atoms; the atoms carrying the charges, or the charges dragging the atoms, according to from which point of view we please to regard the process.

(To be continued.)

* The decimal places are correctly printed above; though the fact that one coulomb or one ampere-second is one-tenth of a c.g.s. unit, owing to the volt having been stupidly defined as 10^8 instead of 10^9, always stands ready to introduce confusion and error.

THE PHOTOMETRY OF ELECTRIC LAMPS.

By Dr. J. A. FLEMING, M.A., F.R.S., Member, Professor of Electrical Engineering in University College, London.

(Abstract of Paper read December 11th, 1902.)

WE frequently see glow-lamp efficiencies expressed in figures running to two decimal places, yet it needs but little acquaintance with the subject of light-measurement to compel an admission that the probable accuracy of the determination of the illuminating power is not often sufficient to justify it.

The wide variations which exist in the case of incandescent lamp tests indicate that many arc-lamp candle-power and efficiency measurements, which involve all the difficulties of heterochromatic photometry, may be even more uncertain in value.

The subject naturally divides itself into the consideration of—

1. Standards.
2. Processes of measurements.
3. Special considerations affecting heterochromatic photometry.
4. International agreements on the subject of standards of light and processes of testing.

I. STANDARDS.

Whilst the sperm candle, six to the pound, burning 120 grains of spermaceti per hour, still retains its position as the legal standard in the United Kingdom, it has been practically dethroned by the action of the Metropolitan Gas Referees in adopting the 10-C.P. Vernon Harcourt pentane lamp as the official light standard for the testing of gas. Probably in a short time the use of the sperm candle will have entirely ceased. General experience shows that candle standards of any kind are inferior to other flame standards using a liquid fuel.

It is generally agreed that a flame standard must comply with three conditions:—

1. The combustible must be of constant and definite chemical composition, easily obtained pure, and tested for purity without difficulty.
2. It must be burnt under simple and easily controlled conditions.
3. Unavoidable changes in atmospheric pressure and composition must not affect the character of the flame sensibly.

Moreover, it should be capable of being set up anywhere and be self-contained. This last condition rules out any coal-gas standard, even if experience had not shown that the Methven screen by no means renders the light emitted by a coal-gas flame independent of the composition of the gas.

The three flame standards which at present hold the field are—

1. The 1-candle Pentane Reference Standard.
2. The more recent 10-candle pentane lamp.*
3. The amyl acetate lamp.

Pentane, a very volatile and inflammable liquid, having the chemical composition C_5H_{12}, is the distillate yielded by light American petroleum after three distillations respectively at 55°, 50° C. and 45° C., and subsequent treatment with strong sulphuric acid and caustic soda. The vapour of pentane is 2·5 times heavier than atmospheric air, and is as inflammable as ether. The specification for its preparation and testing is given in the Gas Referees' Notification for 1901.

It is important to notice that precautions as to testing cannot be dispensed with. Merely to write to a wholesale chemist for pentane, or something called pentane, and then use it in a Harcourt lamp will not result in the reproduction of the standard of light. The pentane used in gas-testing is prepared in bulk by the gas companies, and is then tested by the Referees and supplied in sealed cans to the gas-testing places.† Mr. Vernon Harcourt has devised at various times five forms of lamp for burning pentane, three of them being 1-C.P. standards, and two of them 10-C.P. standards. The most important at the present time is the 1-C.P. standard which was introduced by him to the British Association at Plymouth in 1877.

When the adjustments are correctly performed, a yellow-white flame is produced which yields a light equal to the mean British standard candle, but is much more constant. There are certain corrections to be applied for variations in the atmospheric pressure and moisture and carbon dioxide present in the air.

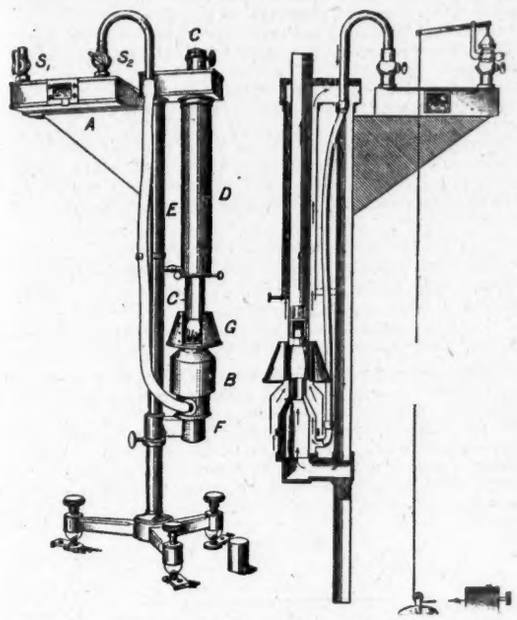
The effects of variations in the hygrometric state of the air and of barometric pressure on the one-candle pentane flame have been investigated by Liebenthal and by Mr. Harcourt. The operations of reproducing a standard of light with this lamp can be obtained from the numerous reports and descriptions of it which have already been given. Its use was recommended by a committee of the Board of Trade in 1881, and by the Standards of Light Committee of the British Association in 1888. It has been demonstrated that this standard affords a means of reproducing with an accuracy of 1 per cent. a light which represents fairly the ideal mean British standard candle.

* See *Proc. British Assoc.*, Bristol, 1898, "On a 10-candle lamp to be used as a Standard of Light," by A. G. Vernon Harcourt, F.R.S.

† Mr. Vernon Harcourt has informed the author that this standard pentane can be procured from Mr. S. E. Miller, of 115, Cowley Road, Oxford, who has had experience under Mr. Harcourt's direction in making it. Messrs. Wright & Co., of Precision Works, Page Street, Westminster, who supply the latest form of 10-candle pentane lamp, have also undertaken to put on sale standardised pentane complying with the above specification.

The following is taken from the official description of the 10-C.P. lamp given by the Gas Referees in their notification for November, 1901:—

"Mr. Harcourt's 10-candle pentane lamp is one in which air is saturated with pentane vapour, the air-gas so formed descending by its gravity to a steatite ring-burner. The flame is drawn into a definite form, and the top of it is hidden from view by a long brass chimney above the steatite burner. The chimney is surrounded by a larger brass tube, in which the air is warmed by the chimney, and so tends to rise. This makes a current which, descending



A, Saturator; B, Burner; C C, Chimney tube; D, Outer tube; E, Pillar; F, Bracket; G, Shade; s_1, Air cock; s_2, Regulating cock.

FIG. 1.—VERNON HARCOURT PENTANE TEN-CANDLE LAMP.

through another tube, supplies air to the centre of the steatite ring. No glass chimney is required, and no exterior means have to be employed to drive the pentane vapour through the burner. Fig. 1 shows the general appearance of the lamp." *

An important point in connection with this 10-candle standard is that it requires and has no glass chimney. Other pentane lamps have been produced in which a glass chimney is employed, but this feature always introduces an element of uncertainty into the working of any standard of light. Moreover, the light from the top of the flame is cut off by the metal chimney, and this probably contributes to prevent the light emitted being influenced by normal variations of atmospheric pressure so much as is the case with open-flame lamps. The light is, however, affected by the presence of water vapour and carbon dioxide in the air.

The third flame standard, which has come into very general use, especially in Germany, is the so-called Hefner lamp. The material burned in the lamp is amyl acetate, $C_7H_{14}O_2$.

The lamp is used without a chimney, and the flame must be carefully protected from draughts. The luminous intensity of this flame is less than that of a British standard candle. Measures of the ratio, however, made by different observers do not agree very well. The most probable value appears to be 0·88.†

The chief objection to the use of the Hefner lamp as a standard is the reddish character of the light. In this respect it compares very unfavourably with the Harcourt 10-candle pentane lamp, the light of which is comparable in quality with that of a glow lamp working at about three watts per candle power. The employment of the Hefner lamp as a means of standardising glow lamps when used at the ordinary efficiencies, gives rise to the difficulties of heterochromatic photometry, and its use in arc-lamp photometry is out of the question.

Variations of moisture in the air, in the height of the flame and in atmospheric pressure affect the light given by the lamp.

The effect of carbon dioxide in the atmosphere on the luminosity is important. Hence in badly ventilated rooms where many people are gathered together, carbon dioxide will be present to an extent which materially influences the light of the lamp.‡

Turning next to the subject of Incandescence Standards of Light, the only practical standards of this description which have been evolved, are those in which either platinum or carbon heated to a high temperature is employed. M. Violle proposed in 1881 to define the unit of light as the light radiated normally from one square centimetre of platinum at its melting point. The International Congress of Electricians in 1889 adopted the proposal that the practical unit of light should be one-twentieth part of the Violle platinum unit. A long research was carried on at the Davy-Faraday Laboratory in 1899 by Mr. J. E. Petavel, who made the Violle unit the subject of a careful investigation.

His inference from the whole of his work is that when carried out with stated precautions, the probable variation in the light emitted by molten platinum under the standard conditions is not above 1 per cent., and he considers that with more perfect apparatus and with certain improvements the accuracy of this standard would be increased.

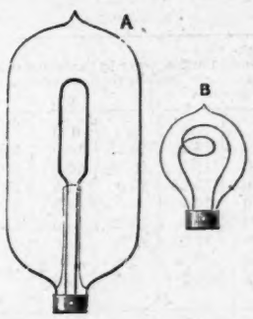
We have grounds, therefore, for the belief that the Platinum Standard in some perfected form may yet prove to be the best ultimate standard of luminous intensity. It is, however, a standard of such a nature that it is not likely to be set up anywhere except at the National Physical Laboratory.

The consideration of the possibility of using carbon filament lamps as standards of light has been very much before the mind of the author during the 18 years that he has acted as scientific adviser to the Edison & Swan United Electric Light Co., Ltd.

The first objection that arises is that a carbon filament lamp alters in light-giving power when used at constant voltage, for three reasons, viz., by—

1. Changes in electric resistance of the filament.
2. Changes in the nature of the surface of the filament.
3. The deposit of carbon upon the interior of the bulb.

It is well known that the candle-power of new glow lamps of the majority of types increases for a short time after they have been put into use. This is due to a decrease in the resistance of the filament. The filament becomes more consolidated and probably denser, and therefore decreases in resistance. If, however, a good filament is run in a lamp at normal, or slightly above normal, voltage for 50 hours or so, it reaches a condition in which a small further use will not much alter it. By that time the glass bulb is somewhat blackened, and the lamp will have lost candle-power. Experiments made by the writer several years ago, showed, however, that if a filament which has been so "aged" is removed from the old bulb and put into a new clean bulb, the candle-power will again be brought back to a value not far from its original value. It therefore occurred to the writer to prevent the blackening of a glow lamp by the following means:—The blackening is caused by the projection of carbon from the filament, and hence other things



A, Fleming-Ediswan standard glow lamp; B, Ordinary Ediswan 16-C.P. glow lamp.

FIG. 2.

being equal proceeds most rapidly in small bulbs, because the carbon molecules then most easily reach the glass. Suppose, however, that a filament is mounted in a very large bulb, the radius of which is much greater than the mean free path of the molecules at the pressure of the residual air. The chances of a molecule of carbon getting on to the glass are much reduced. Accordingly, about six years ago, the author requested Mr. E. Gimingham, superintendent of the Edison and Swan Electric Light Factory, to mount some 16-C.P. filaments in very large bulbs, and it was found that these lamps could be run for long periods without any of the usual blackening or loss of light. This observation led, therefore, to the following method of constructing a special form of carbon filament lamp to be used as a standard of light. Carbon filaments of the old Edison horseshoe shape are well selected and carefully treated, and are then mounted in ordinary bulbs, and run as lamps for some time, at about 5 per cent. above marked voltage for about 50 hours. Those filaments which then show no defects are cut out of these slightly blackened bulbs, and mounted in very large clear glass bulbs, 6 or 8 in. in diameter. These lamps, if not very much used, and not worked above a certain marked voltage, will remain practically constant for any length of time.

In 1896 a good many experiments were made on this plan at the Edison and Swan Lamp Factory.* A number of these large bulb

* The author is indebted for permission to make use of the block of fig. 1 to the editor of the *Journal of Gas Lighting*.

† This is the value taken in a specification for the supply of glow lamps issued by the General Post Office.

‡ For a series of curves showing the variation of the Hefner lamp with barometric pressure and moisture, see the ELECTRICAL REVIEW, Vol. xlii., p. 759, 1898.

* The author desires to take this opportunity of gratefully acknowledging the kind encouragement and valuable support he has continually received from Mr. J. W. Swan, F.R.S., in this and many other similar investigations during the whole period of his connection as scientific adviser with the Edison & Swan United Electric Light Co., Ltd. In addition, the author has pleasure in referring to the assistance rendered by Mr. E. Gimingham in working out this form of Standard Ediswan glow lamp.

lamps were prepared, and carefully photometered against a pentane air-gas standard as giving us the best means of fixing at that time a standard equal to 10 British standard candles. The working voltage of the lamps was carefully measured by means of a potentiometer and a Clark cell, and the candle-power, voltage and current recorded on each lamp, the candle-power taken being that in a horizontal direction and perpendicular to the plane of the filament when the axis of the filament was vertical. A certain number of these lamps were set on one side, and called primary standards, with the intention that they should be used only very occasionally for verifying the candle-power of others of the lamps, which were called working, or secondary standards. These secondary standards were to be employed to set the working lamps in the various photometer rooms.

A similar set of primary and secondary lamps of this description was made for the Pender Laboratory, University College, London. These lamps have been in use for several years in the Edison and Swan Co.'s Factory at Ponder's End, and at the Pender Laboratory, and have been found to be very convenient. In the month of March, 1902, with the kind co-operation of Mr. E. Gimingham, some experiments were made at the Edison-Swan Factory, Ponder's End, to ascertain how far any difference might have arisen in six years between the pentane air-gas standard used there and certain of these standard carbon filament lamps. The lamps were accordingly checked in a photometer room, using a Lummer-Brodhun photometer to measure the light, and a Crompton potentiometer and Clark cell to measure the current and voltage. In order to eliminate the personal error, three or more observers were admitted to the photometric gallery. This somewhat unusual proceeding, however, and the want of attention on one occasion to the ventilation, resulted in revealing an apparent discrepancy between the candle-power of the lamps as measured in terms of the pentane flame in 1896, and those made in March, 1902.*

If we were entitled to take for granted that the pentane standard had remained unaltered, the results would seem to show a falling off in the candle-power of the glow-lamps in the six years. This, however, is not a valid conclusion. The presence of an unusual number of persons (four) in the photometer room vitiated the air towards the end of the time of observations. The doors were, therefore, all thrown open for 40 minutes, and after the air in the room had been thoroughly renewed the measurements were repeated as below :—

Readings taken with Photometer Room well Ventilated.

Mark on standard glow lamp.	Working volts on lamp.	Candle-power by pentane standard read by three observers. (i.)	(ii.)	(iii.)	Mean C.P.	Candle-power of glow lamp as determined previously.
Pender I. ...	96·0	14·4	14·25	14·0	14·22	14·25 in 1896
Pender II. ...	96·0	16·5	16·7	16·0	16·4	16·4 in 1896
Pender III.	96·0	12·75	13·0	12·5	12·75	12·75 in 1896
Pender IV. ...	96·0	14·1	—	13·9	14·0	14·5 in 1896
Pender V. ...	96·0	15·5	15·25	15·0	15·4	15·55 in 1896
Pender VI. ...	96·0	11·9	11·7	11·65	11·75	11·5 in 1896
Ediswan S_2...	96·2	10·1	9·8	9·8	9·81	10·0 in 1901
Repeated...	„	9·7	9·65	9·8		

During these tests the temperature of the Clark cell rose from 16° C. to 20° C. This alone would imply a possible error in voltage of 0·36 per cent., and an uncertainty therefore in candle-power of 1·8 per cent. The results of the measurement are, however, to show that in six years, during which these glow-lamp standards have been much used, the set belonging to the Pender Laboratory have probably remained as constant in light-giving power at the same voltage as the pentane standard. Since a standard glow lamp of this form, used as described in the next section of the paper, is only in a state of incandescence for a few minutes at a time during each test, the use of such a lamp in many hundreds of tests only amounts in all to a few hours' burning. It is clear, therefore, that if the filament has been brought into a condition in which it has passed the initial variable stage during which changes may take place in it, and if after that time it is only used for exceedingly short periods of time, and in a large bulb as described, it becomes a means of preserving a standard of light with great constancy.

In the case of the test made with the standard lamp Pender IV. it will be seen that the candle-powers were only read by two out of the three observers. With this exception, none of the lamps which have been in use in the Pender Laboratory for six years now appeared to differ from the pentane standard by more than 2 per cent., and in the majority of cases there is no sensible difference; the whole of this difference, where it appears, must not be set down to changes in the incandescent lamp. In fact, these large bulb glow-lamp standards were easily able to detect a temporary variation in the pentane standard due to inattention to the ventilation of the room.

* The observations in 1896 were made with great care by Mr. J. T. Morris, at one time private assistant to the author, but now Lecturer on Electrical Engineering in the East London Technical College. The observations in 1902 were made under the direction of Mr. W. C. Clinton, B.Sc., Demonstrator in the Pender Laboratory, to whom the author is indebted for valued and willing assistance in the experiments here described, as well as many others related to this investigation.

The experience gained by the writer in the last six years, and also at the Edison-Swan Lamp Factory, justifies the expression of opinion that these large bulb standard carbon filament lamps form a very convenient and accurate means of preserving a standard of light, when proper precautions are taken to set them to a marked voltage by means of a potentiometer and Clark or Weston standard cell.

It was proposed by Mr. Swinburne, Prof. S. P. Thompson, M. Blondel, and others, that the light from one square millimetre of the crater of the arc lamp should be taken as a standard of luminous intensity. Measurements of the intrinsic brilliancy of the crater by different observers do not agree very well, and it cannot be said that the experimental work done so far holds out a promise that this source of light will fulfil all the requirements of a standard.

The conclusion, therefore, which may be drawn from the preceding facts is that at the present moment there are five sources of light which can, in all probability, be regarded as sufficiently constant to enable them to be used for reproducing a standard of luminous intensity with a degree of accuracy approximating to 1 per cent. or less. Two of these may be called primary or reference standards, and three working standards. The primary standards are :—

1. The Violle platinum incandescent standard.
2. The Vernon-Harcourt pentane 1-candle flame standard ;

and as practical working standards :—

3. The Hefner or amyl acetate lamp.
4. The Vernon-Harcourt self-contained 10-candle pentane lamp.
5. The Fleming-Ediswan large bulb incandescence electric lamps.

The first two reference standards can be relied upon to preserve a selected standard or unit of light with an accuracy which is comparable with that of photometric measurements generally.

Of the three working standards, the amyl acetate lamp is decidedly inferior to the other two in the quality of its light, and difficulties arise in using it even to standardise glow lamps, whilst it is quite unsuitable for use with arc lamps. Moreover, experience shows that a 1-candle standard is not so generally useful as a 10-candle.

(To be continued.)

METROPOLITAN ELECTRIC SUPPLY CO.'S ARBITRATION.

(*Continued from page* 1091, *Vol.* 51.)

Resuming his speech on December 18th, Mr. Fletcher Moulton said he had now come to the most important and the most difficult part of the inquiry, that was to say, the field for lighting in Marylebone in the future. It could not be concealed that that was both for the claimants and the Borough Council a point of great difficulty, requiring a good deal of careful thought, because it meant a long look into the future, and it was not one of those cases in which one was only repeating a process which had been performed many times, and in which the accuracy, or the contrary, of methods of prophecy had been tested by results. Electric lighting began in England shortly after the Act of 1888. The early orders were for 42 years, so that practically all the electric lighting undertakings in England were quite early in their development; that was to say, they had only just completed the first quarter of their existence, so that they had got no past experience as to what the growth of electric lighting would be in the future, and if they looked abroad they were in a similar position. Certain electric lighting undertakings had been in operation for a larger number of years than any in England, such, for instance, as that of Berlin, but still the bulk of electric lighting undertakings there also were young. Now, of course that gave great latitude for differences of view, and it was not very surprising that, on a point like that, which might be quite legitimately controversial, there should be a broad difference between those who looked forward enthusiastically to the future and those who looked forward critically. He was not complaining at all that Mr. Conacher's tables put forward a field for electric lighting in Marylebone with which they could not at all agree. But, while he said that, he did not mean for one moment to abandon the position that they could arrive, with a reasonable degree of certainty, at what must be considered the probable field in Marylebone attainable by 1931; but it tested one's methods very severely, and before one drew conclusions as to the field, one had to examine very carefully the lines of evidence, in order to test both their reliability and the conclusions to which they pointed. Mr. Conacher's tables were confessedly based on what he called past experience, and he drew conclusions as to the future of the undertaking from the history of past years. Now he (the learned counsel) joined issue at once on that—he said that they could only draw conclusions as to the future growth of a concern from the past, if the past and the future were both examples of what he might call normal growth. Initial growth was no clue to normal growth. By initial growth he meant this—that when they brought in a new article the demand for it at first was checked by its newness, but after it had become known the demand for it was measured by the unsatisfied want for that known article, and there came a period when the demand entirely depended on how great the demand left unsatisfied was. Take the years that this company had lived. They had got to separate the growth of the company due to

the fact of the want of electric lighting existing and having to be satisfied from anything that they could call normal growth, and although they would allow for a year or two, still they had got to find out from examination of the statistics or from elsewhere what would be the normal growth when the thing was saturated. That it would be saturated in a very short number of years was certain—it must be, for the people who wanted it would have taken it. It was a common thing now to have electric light—there was nothing pioneer about it. Sooner or later all the people who were desirous to take it would take it, and then, of course, would come the case in which the growth had nothing whatever to do with the fact that it was a novelty, but would simply be from the natural development of the community in wealth. Nobody could seriously think that electric light was going to get the total illumination in Marylebone. On the contrary, gas had become six or seven times more formidable as a competitor, and he would be able to show that gas had become so formidable a competitor that it was not at all unlikely that when the two came to clutches electric light would have to a certain extent to go back. He had not the slightest doubt that incandescent gas was making its way. It had first of all to drive out the old method of using gas. Electric lighting had got a capital time just at present, because it was dealing with people who took electric light and would not take gas. But wait until the ground was pretty well covered with incandescent gas and electric light, and when they came to consider the advantages of the two, he thought it was probable that what had occurred on the Continent and in Stepney would occur in Marylebone. At Stepney they had got the fact that electric light was being made to recede by the incandescent gas. If illumination was very much cheaper, it was quite probable that people would indulge in it more luxuriously—that was quite natural; but let them take the question of gas. He had taken it that 8,000 cub. ft. per head—that was about £1 4s. per head—satisfied them in 1889. In their suggested cost they had allowed 96 units per head, and supposing they took that at 4½d., they had then allowed the community to spend 36s. instead of 24s., which was certainly a very serious increase. But what did the company suggest? They suggested that the whole community would spend 73s., which was three times what they spent in 1889. That was to say, that the people who were going to have electric light would spend three times as much, not only as they spent, but as the whole community spent; it was not £3 13s. *per person* who took electric lighting, but *per head of the whole population*, so that the portion who were going to take electric light would spend not only three times as much as they now spent, but three times as much as everybody spent. That was not because gas light had become dearer, for the incandescent method of using gas gave it about one sixth the price for light, apart from installation. Let them contrast the estimates of the company with what they found in other districts. Take Berlin, where they began electric lighting six years before we commenced it in England. If he remembered rightly, in that country it was about 11 units per head or less. There were 2,000,000 people in Berlin, and, if he remembered rightly, the total for light and power was something like 22 millions—that was to say, only about 11 units per head. If they looked into the question of gas consumption, they would find that Marylebone stood very high, and naturally it would do so, because it was a place where a great deal of light would be burning. With regard to the past increase in the company's electric lighting consumption, they knew perfectly well that the conditions under which those increases had taken place were initial conditions, and how in the world could they assume that that would be going on in the future? As to the demand in Marylebone for private purposes, the whole of the evidence pointed to the fact that the company had substantially got hold of the *clientèle* that awaited them. He did not mean to say that they would not get any growth even when they had got the whole of their *clientèle*, but those that were left were people who were not prepared to pay any price for illumination, but they were people to whom money was important, and who would use the illuminant that was cheap and effective. Undoubtedly the question of incandescent gas was a feature of the very greatest importance in this case, and one to which weight must be given by the tribunal in the performance of their task. As to that there was really very little controversy—the evidence that he had called with regard to incandescent gas was very little challenged. It could not be challenged. The facts were getting more and more patent to the public, and it was astonishing that the public had not got further with the use of incandescent gas in England, but it was to a certain extent, like electric light, in its initial stage. The Nernst lamp which had been referred to by witnesses of the company, was a lamp which would probably be a very serious difficulty to them in the future. It would not alter much the competition of the incandescent gas, because the Nernst lamp was a lamp which always was a powerful lamp. It was not as powerful as the arc, but he had never seen any Nernst lamp which would be under something like 100 candles. In the lighting of private houses he did not believe that the Nernst lamp would take any part, but they had got to face the fact that there was double the amount of illumination to be obtained by the same amount of electricity. Therefore with the same amount of electricity at disposal, it was possible that there might be a serious diminution in the amount of electricity required. Of course it cut in the favour of the company in one way, for it brought the cost down merely to the level of the cost of incandescent gas, which might enable them to bear the struggle with incandescent gas better, but it did not touch the incandescent gas in cost, and he thought it would probably lessen the profitableness of a good deal of the illumination that they had at present. Turning to the question as to the price at which the company would have to sell its light in the future, the learned counsel said there was very little difference on that point between the company's case and that of the Borough Council excepting initially, because they took it that the company had more or less the right to fix the price. Of course, if they had fixed a much lower price, they probably would have increased their field to some extent. He was not saying that they were wrong in fixing the price that they proceeded to fix for the future, and he thought it very probable that they increased their profits by keeping up the price. Of course, if they could drop it to a very very much lower price they would increase the field, but he did not think that would very seriously affect the competition of the gas. Turning to the question of working expenses, Mr. Moulton said he wished to say that he joined issue entirely with Mr. Conacher's conclusions on that point. Mr. Conacher had not even calculated what it was per unit; what he had done was to take a percentage of the revenue, and for about half the time he had taken a percentage of 40 per cent. on the revenue as the total working expenses. There was no possible justification for that—they must find what the cost of the unit was.—Adjourned.

On December 19th Mr. Fletcher Moulton finished his address on behalf of the Borough Council. He put in some tabulated figures with regard to the contrast between London prices and Marylebone prices to illustrate that the difference between them was extremely substantial, and no doubt either justified a considerable alteration of the legitimate price in Marylebone, which was the only price they could calculate upon in the future, or would have increased the cost of the Marylebone supply over the average of the undertaking. Turning to the question of depreciation, the learned counsel said there was a great difference between depreciation and the present value. He quite agreed that the 1½ per cent. negatived depreciation according to the scheme—which meant that at the end, in cash and in purchase price, the company would get the capital they started with now, viz., £194,000 odd, but, of course, that they were entitled to only in 1931. The consequence was that now they were entitled to its present value, and the question was, at what rate per cent. were they entitled to it? It was extremely difficult to say on what scale that ought to be done. They had put it down as 5 per cent., which was very much a business rate; 3½ per cent. was a high-class investment rate. Now, that was an admitted sum, which would be due in 1931. It was due in the line of a business dependent, of course, on the business being successfully carried on till then. It had a certain element of business risk, but not an element of business risk comparable to the business risks that surrounded profit, because it was an ascertained amount. They had put it down at 3½ per cent., but his learned friend had put it down at 5 per cent., and it must be left to the judgment of the tribunal to say which it ought to be. He admitted at once that it must be a lower rate per cent. than profits, because there was an absolutely ascertained sum. At the same time, it was not quite free from business risks, and 3½ per cent. was, of course, a very low rate per cent. for anything to do with business. If they came to the conclusion that it ought to be 3½, or 4, or 4½, or 5, they must apply it; 3½, he admitted, sounded to him too small; 5, on the other hand, was Mr. Marshall's view. He said it ought to be 5, and they might perhaps think that too high, but he wanted to put it before them quite fairly. He did not think it was at all a question whether they ought to have a high rate, because it was profit; at the same time, he did not think it ought to be so low as 3½ per cent. Then came the question how they were to estimate the present value of the net profits. One thing was quite evident, they could not take them in any way as being certain to be received. Many things might happen. There was the competition of gas, which might prove a great deal more formidable than some people thought. The cost of light might be diminished by reason of electricity getting more economically used in the way of lighting. Of course, they knew that electricity could not be more economically used in the way of power. They knew the maximum amount of power that could be got out of electricity—no invention could increase that. They knew that 1,000 units made 1½ H.P.-hours, and more than that it could not be, but as to light, it was possible people might get much greater light out of the same amount of electricity, because the light depended not on the total amount of heat that was used, but on the temperature at which it was used, and when they got a thing with a tremendous temperature, they got a vast amount of light compared with what they did with a low temperature. There might be things like the Nernst lamps that might diminish the amount of revenue to the company for the same amount of light. There might be many of those risks, and so they had to look upon it as trade profits. If they had to look upon it as trade profits, one thing was certain—that no such thing as 3½ per cent. was permissible, or anything of the sort. What was the usual custom with regard to valuing the profits of a business? It was to ascertain the net profits, and taking a small number of years as being the factor by which they must multiply it in order to get the price at which they were going to sell the business. Three years was common; five years was rather extreme, showing that people did not, when they were dealing with profits, look upon it as a percentage of a capital amount, and that they were entitled to the capital amount. They looked upon it that, with all the risks of business, they must be content with a certainty of a few years' profits, instead of the possibility of continuing those profits for long years. Business profits were contingent on their being earned, and the fact that they were selling the business did not change business profits into investment profits. There was still the obligation to earn on the part of the purchaser. The vendor got rid of that obligation to earn. He had thought a great deal as to how he should put that, and in his opinion they ought never to take profits as if they were to receive a revenue from investments. The business profits in the present case were

hedged about with many dangers. But the company had calculated the probable profits on the assumption of their being freed from those dangers. As indicative of the very substantial trade risks that there were, they might have to recommence and re-instal the system, and work from Manchester Square and Rathbone Place, after committing themselves to the enormous expenditure at Willesden, or what would come to the same thing to make terms with the persons who had the right to compel them to give a self-contained supply. Then it must always be remembered that this was a terminable concession. It was like a leasehold value, not a freehold, and they had to consider what would be the value at the present time and what would people be prepared to put down for the chance of getting it. He said that a man would not take possible profits, even probable profits, between five and 15 years, unless he had a sporting rate per cent., that was to say, a rate per cent. more than investment. It was taken at 7½ per cent. in their table, and beyond 15 years with the uncertainty of what those profits might actually be, and with the great dangers that surrounded them which would cut down those profits enormously, he certainly would not be willing to give more than on the 10 per cent. table. The other side had calculated its profits, assuming everything for the best. It had said that all the profits of this year, and he believed the profits which they had calculated in 1904, were absolutely certain. They had taken 3½ per cent., a very first-class investment rate for their income all through the time, because they said it was absolutely secure. But was it secure? Suppose they were right in saying that there ought to be mid-London prices which fell to much below the present, and if they took competition, it fell below, in later years, the present income; but suppose they took competition, and then suppose they started with mid-London prices, then there would be a further reduction, and over and above that, there was the certainty that if there was competition, business management, and good business management would be essential to the life of the affair. He could not understand how anybody could come and say that this company was so secure that by no accident could it ever come to an income less than that which it would be in 1904. The struggle between electricity and gas was only beginning, but it was beginning under circumstances which made the profits of electric lighting companies by no means secure, because gas had its capital invested and laid down, and that capital was capable of supplying in the future, as Mr. Gordon Salomon had pointed out, a very much larger amount than it had in the past, without any serious addition to the fixed capital, because they were supplying at higher pressure—they were supplying a cheaper gas, and the consequence was that while electric light companies had to look about for their capital, gas practically had no addition to its capital. It had got it all ready for the struggle. What it wanted was custom, and they might be perfectly certain that when the struggle came, electric lighting companies that were perpetually wanting capital, would find themselves at a great disadvantage compared with gas which had not any of those great demands. Then he would like to say that the method of splitting profits adopted by the company was a wrong one; no portion of those profits was secure. It was a sort of thing that had been done in stock-splitting, to the great advantage of the person who split the stock, but certainly not to the advantage of persons who bought the split stock since. There was an attempt to turn a business investment into two parts—a purely investment part and the purely business part. There might be cases in which that was possible, but it was inapplicable to a company in which the whole of the profits were of the same type. The whole of the profits were business profits, and the whole of them might be imperilled by an accident which threatened the business—if a peril came it would affect the whole bulk of the profits, and when that was so the attempt to divide into two parts was clearly wrong. One could easily imagine that there might be a business in which one portion was very much like lands and the other portion very much like business profits, and it might be possible that they might have a certain portion of payment out of profits which would be fairly called the investment profits, because even with the peril of the business that would be safe; but that did not apply to a case like this, where they had tremendous capital obligations. They did not know that they would be able to raise their capital in the future. Suppose this profit were threatened and they still had to raise the necessary increase of capital; they might have to raise it at great sacrifice. Learned counsel then referred to what he said might be called the outside electrical evidence given by Mr. Swinburne and others, and he said that certainly Mr. Swinburne had given evidence in a way which so contrasted with the evidence that one was accustomed to hear from him in the witness-box that it was to him (Mr. Moulton) amusing. He did not for one moment say that Mr. Swinburne on that or any other occasion had given any evidence which he did not sincerely believe, but the contrast between the sharp, clear-cut scientific evidence one was accustomed to hear from him and the vague generalisations that he had put before the tribunal was very considerable. In concluding his speech, the learned counsel said he wished to put before the tribunal the figures which he said were the right ones for the award. First of all there came an estimate of present value of profits, and that, he suggested, was to be obtained by the tribunal from the consideration of the figures given in Table 5, which they had put in. He would point out that over all that there hung a cloud of the most uncertain position in which they stood with regard to having been liable to be called upon to give a self-contained supply, and also with regard to competition. Those considerations, so far as they were adequately expressed in their multiplier, had to be considered by the tribunal in deciding the figure which was to be deduced from their figure of 389,347. That was the figure which was the one from which that item of the valuation was to be derived. Then the present value of the terminable value of the plant was derived from that figure, which he did not believe was contested at all—the 194,000 on which Mr. Wright's valuation stood. He had not considered that in detail because he had not got to contrast it with any other item, and he was sure that Mr. Wright's *bona fides* in making that estimate would not be challenged by anyone. They had therefore discounted on the 5 per cent. table, because, beyond question, it was not due until 1931, and it had got to be discounted for the years between—whether on the 5 per cent. table or any table, the tribunal had to decide. Then the next question was the buildings and the sites, and that was got from their valuation by Mr. Marshall in 1931, discounted. There was, of course, another way of getting it which would be based on Mr. Stenning's and Mr. Walker's valuation. They could get it in that way by taking their valuation at present, but charging the company with interest on that during the period of getting the present valuation, and those charges would be the same thing, taking the difference between the value at the present and the present value on the same sum in 1931 and adding that as the figure corresponding to buildings and sites. Then there came the question of severance, and he had already dealt with all the items there—they all depended on principle. With regard to the question of costs, he submitted that the tribunal had to carry out the principle of the Lands Clauses Consolidation Act, and they must consider the fact that the Borough Council had had no particulars whatever of the concern.

The Umpire: Have we anything to do with costs?—There is no special reference to costs in the Act. I take it that they follow the ordinary rule under the Lands Clauses Consolidation Act.

Mr. Balfour Browne: It is the Lands Clauses Consolidation Act. There has been no offer.

Mr. Fletcher Moulton: You will consider that, sir; I point out to you that we had no opportunity of making a sealed offer.

Mr. Balfour Browne: And there has been none made. You will have to consider that question.—Adjourned.

TRAIN LIGHTING BY ELECTRICITY.

By A RAILWAY OFFICIAL.

The *Engineering Magazine* for November prints an interesting review of a paper recently read by Herr Wichert before the German Society of Mechanical Engineers describing experiments on train lighting by electricity on the Prussian State Railways. The system experimented with consists of independent steam generating plant carried on the locomotive, supplemented by storage cells carried on each car.

Small steam engines are "steam eaters," or "steam worriers," as is well known to those who have to deal with them, and therefore most uneconomical. To obviate such losses a De Laval turbine of 20 H.P. was used to operate the electrical generating plant, as small turbines were considered to be nearly as economical as regards steam consumption as larger sizes.

The turbine and dynamo were mounted on one bedplate on the top of the locomotive boiler, and arrangements were made to allow of operation of the valves of the former by the driver from the cab. The turbine ran at a speed of 20,000 revolutions, and it was geared down to 2,000 at the dynamo. The latter gave 180 amperes at 68 volts, or 16·4 E.H.P., showing an over-all efficiency for the generating plant of 82 per cent., if we consider the rated horse-power given above as indicated horse-power, which, however, is not directly stated. For so small a plant, this efficiency is high.

Besides the generating plant, each car on the train was equipped with a storage battery of 32 cells to take up the lighting at such times as the locomotive might be disconnected from the train. The cells were capable of maintaining the light in the car for about 3½ hours.

Probably the most interesting part of the summary is that relating to the results obtained. We are told that:—

1. The cost of electric lighting, according to Herr Wichert's figures, is about three times that of oil gas "as employed in the Pintsch system, for example."

2. The steam consumption of the turbine was from 42 to 45 lbs. per H.P.-hour.

3. There is no doubt that electric lighting is by far the best for use on railway trains, so far as convenience and satisfactory illumination is concerned.

4. The brilliance of the light is unsurpassed.

5. The general control of the illumination which can be given to the lighting of the whole train is an important feature.

6. The air of the compartments is not vitiated.

7. The influence of draughts of air, so important in connection with oil and gas lighting, becomes negligible.

It is not necessary, perhaps, to discuss all these matters in detail; for the ordinary practical man the first two will be almost sufficient. The use of independent generating plant carried on the locomotive, and taking steam from the boiler, deserves some consideration. The system depends for its operation upon every locomotive which may have to draw the train, being fitted with an engine and dynamo, and with the necessary wiring, and throws upon the engine staff the duty of attending to the plant in addition to their other responsibilities. That these duties are sufficiently onerous of themselves is

generally admitted: indeed, one has known objections to be made by locomotive engineers to the addition of far more essential apparatus, from an operating point of view, on the ground that drivers had as much apparatus to look after as they could attend to.

From the traffic point of view, also, we find that the division of any train so fitted would depend upon the charge in the cells of cars which are taken off the train being sufficient for the remainder of the journey they had to make, with locomotives not fitted with generating plant. The breaking up and rearrangement of trains at different points on their journeys is an important part of the organisation of railways in this country, and, moreover, there is the break of continuity to be considered, introduced by the change of engines when a train passes from one company's lines to another. "Runs of 100 to 250 miles without a stop," which such a system is considered more particularly adapted for, are rare in these islands.

From the standpoint of the locomotive engineer it is a question whether taking steam direct from the boiler of the locomotive for the operation of the electrical generating plant is not even worse than taking power from the axles of the train, in so far as it affects the working of the locomotive for hauling purposes. Such arrangements can only be justified from an engineering point of view, when it is shown that the efficiency of the small separate engine is higher than that of the locomotive. It is true that in this case an exceptionally high efficiency is shown for so small a combined plant by taking the rated horse-power of the engine, but it does not appear from the review that any tests of this description were made, and it may well have been that the turbine indicated horse-power was greater than its rated value when the dynamo was giving its maximum output.

It is desirable at all times to look facts in the face. Train lighting by electricity has, so far as this country is concerned, had its trial. Such a system as that just considered, looked at from the lighting point of view only, seems quite suitable for long-distance traffic, and even more suitable than the method of taking power from the axles of the train, whether by one dynamo or by many, for frequently stopping trains, inasmuch as the time during which the dynamos are available for charging the cells may often be less than that during which the latter are discharging, and there may, therefore, be difficulty in keeping them sufficiently charged. Looked at from other standpoints, electrical systems other than those in which the cars are self-contained are deficient in flexibility to meet the conditions of operation satisfactorily.

Finally, electricity has to meet competition from a system which is "set," and which, following the principle of giving even the devil his due, it may be said gives a very good service.

THE USE OF BLAST FURNACE GAS IN GAS ENGINES.

THE latest information on the utilisation of blast furnace gas in gas engines is contained in a paper delivered before the Cleveland Institution of Engineers on Tuesday, December 9th, 1902, by Mr. Cecil A. Cochrane, and as we have given considerable space to the possibilities in this direction, we think it worth while to review the results then brought forward.

The paper is devoted to the application of Cleveland blast furnace gas to the direct driving of a blowing engine; but the utilisation of this gas as a cheap and economical source of power available for electrical purposes is of more interest to our readers. We shall therefore chiefly confine our remarks to the points referring to the successful driving of gas engines by means of this by-product of the blast furnace. In the Cleveland district alone, according to Mr. William Whitwell, there should be available gases capable of developing 61,000 H.P.,* and the application of this power to the generation of electricity is a matter well worthy of serious consideration.

Mr. Cochrane, after referring to the present waste of gas, even while coal is being used at the boilers, says that probably the two most important papers for iron manufacturers recently read, were those of M. Adolphe Greiner to the Iron and Steel Institute, May, 1898, and Mr. H. A. Humphrey to the Institution of Mechanical Engineers, December, 1900. In this connection we are at a loss to understand why all the other numerous papers and contributions to the Press on this subject, in this country and on the Continent, should have been ignored, as in regard to the use of blast-furnace gas in gas engines, M. Greiner's paper was not only not the first given on the subject, but his conclusions as to the cleaning of the gas being of no considerable difficulty or importance were, to say the least, misleading; while Mr. Humphrey's paper did not deal particularly with blast-furnace gas.

The gas engine in question was of the "Simplex" type, and before giving the order for it, Messrs. Cochrane took precautions to ascertain that the gas from the Cleveland furnaces was suitable for driving it; Mr. Cochrane was present at the official tests, of which he gives the results, together with particulars of the engine, discussing the methods of governing and ignition, as well as of starting and cylinder cooling.

The principal dimensions of the engine are:—Gas cylinder, 4 ft. 3 in. diameter; double-acting blowing cylinder, 5 ft. 7 in. diameter; stroke, 4 ft. 7 in.; normal speed, 78 revolutions per minute. The blast is delivered at a pressure of 7 lbs. per sq. in. The fly-wheel, in two halves, weighs 33 tons, and has a diameter of 16 ft. 6 in., while the whole engine weighs 150 tons, and occupies a space 52 ft. 6 in. × 21 ft. 9 in. Governing is effected on the hit-or-miss principle. Electric ignition is employed, adjusted by a timing valve giving very satisfactory results.

There is no special arrangement for scavenging in this engine. The combustion chamber and cylinder are, however, swept out when the governing apparatus comes into operation, a charge of air alone being drawn in and expelled. As a consequence, the first explosion after a "miss" is always greatest in intensity, subsequent explosions giving a reduced initial pressure, owing to the fouling of the air in the combustion chamber by the products of combustion.

The number of misses varies from 1 in 4 to 1 in 30, according to the quality of the gas and the pressure against which the engine is blowing. We have pointed out in previous articles that it is not generally found that the *quality* of the gas from any given blast furnace varies over any appreciable range, but, when it is used in a gas engine for driving electrical generators, especially alternators that are to be run in parallel, it is necessary to apply a scavenging arrangement, so as to make the impulses as nearly as possible constant in intensity, and to govern by the regulation of the charge of gas and air, instead of the hit-or-miss system, in order to keep the cyclic irregularity within such bounds as to prevent the alternators being thrown out of step or a heavy surging current being set up.

With regard to the cleaning of the gas previous to its application to the gas engine, Mr. Cochrane says:—"In approaching the problem of how to clean the gas, then, we were fortunate in having the experience of Differdingen to guide us, and we never had any hesitation in adopting the 'dynamic' method of cleansing as it is called, in preference to the 'static' method, the former being cheaply applied, very efficient, and occupying little space (this being of great importance at our works)."

A comparison between the static method, as described in our previous issues, and the so-called dynamic method as installed at Ormesby, hardly inclines to a preference for the latter.

In the static system there are washer boxes, condensers, propelling fans, coke, and sawdust scrubbers.

At Ormesby the gas for the 600-H.P. engine is passed through a long system of tubing 5 ft. 6 in. in diameter, and a stove casing, constituting a crude cooler or condenser, in which dust accumulates, this accumulation reducing the cooling property of the tube as the deposit of dust on its internal surface increases, until the necessary periodical cleaning is effected.

The installation of a fan (the dynamic part of the apparatus) and water supply, even with the assistance of the 1,100 ft. of tubing, was not found to be sufficiently effective, so a more or less temporary arrangement of coke scrubber was arranged.

Particulars are given of the quantity of water and the power required to drive the fans, as well as the cleansing effect obtained, from which it is clearly shown that the speed of the fan and the quantity of water injected have to be regulated to a nicety to enable the engine to be run satisfactorily. Moreover, difficulty is experienced through the moisture introduced into the gas.

From the points mentioned above, as well as the further details given in the paper, it appears to us that the apparatus, taken as a whole, is of a crude and expensive character

* *Transactions of the Iron and Steel Institute*, May, 1901.

while it is not distinguishable in principle from the static method referred to, which, by means of apparatus specially designed for each particular purpose, has been found to be so effective as to draw remarks of approval even from M. Greiner. We notice that our contemporary *Engineering* contains some interesting correspondence on the subject, but we shall defer consideration of the points discussed to a later issue.

NEW PATENTS, 1902.

Compiled expressly for this journal by W. P. THOMPSON & Co., Electrical Patent Agents, 322, High Holborn, London, W.C., and at Liverpool, to whom all inquiries should be addressed.

27,571. "Improvements in and relating to electric tramcars." S. D. MCKELLEN. December 15th.

27,574. "Improvements in reversible boosters." D. BRUCE PEEBLES & Co., and M. T. PICKSTONE. December 15th.

27,601. "Terminals for fusible cut-out in electric circuits." G. C. GEISLER. December 15th.

27,605. "Improvements in electric ozone physical exercisers." B. C. MOLLOY. December 15th.

27,618. "Improvements in devices for varying the resistance of an electric circuit." SIEMENS BROS. & Co., LTD., and A. SIEMENS. December 15th.

27,619. "Improvements in the control of electromotors on electric railway cars." SIEMENS BROS. & Co., LTD., F. LYDALL and A. M. DUKE. December 15th.

27,635. "Improvements in collectors for overhead electric conductors." S. J. ROSEBLADE. December 15th.

27,644. "Electric thread breaker." B. DIZEWIECKI. December 15th.

27,657. "Improvements in and relating to the arcs of arc lamps." T. L. CARBONE. December 15th.

27,676. "An improved form of hydraulic press for assembling the parts of electrical commutators, tightening the ends of commutators and pressing together the discs of electrical armatures." A. F. PETCH. December 16th.

27,678. "Improvements in and relating to induction coils used for ignition and other purposes." W. J. CHARLES and A. WATSON. December 16th.

27,706. "Improvements in or applicable to fusible electric cut-outs." H. S. PARKER. December 16th.

27,730. "Improvements in electric batteries." D. H. WILSON. December 16th. (Complete.)

27,739. "Improvements relating to means for transmitting and receiving electric signals." H. H. LAKE. (J. S. Stone.) December 16th.

27,742. "Improvements relating to the method of transmitting and receiving electric signals" H. H. LAKE. (J. S. Stone.) December 16th.

27,752. "Improvements in arc extinguishing devices." E. A. CAROLAN. (The General Electric Co.) December 16th.

27,753. "Improvements in bearings for electric or other measuring instruments." E. A. CAROLAN. (The General Electric Co.) December 16th.

27,754. "Improvements in apparatus for forming coils for dynamo-electric machines." E. A. CAROLAN. (The General Electric Co.) December 16th.

27,755. "Improvements in electric furnaces or muffles." E. A. CAROLAN. (The General Electric Co.) December 16th.

27,756. "Improvements in convertible cabs for railway cars." E. A. CAROLAN. (The General Electric Co.) December 16th.

27,757. "Improvements in electric heaters." E. A. CAROLAN. (The General Electric Co.) December 16th.

27,758. "Improvements in machines for cutting micanite and the like." E. A. CAROLAN. (The General Electric Co.) December 16th.

27,759. "Improvements in control systems for searchlight projectors." E. A. CAROLAN. (The General Electric Co.) December 16th.

27,760. "Improvements in electric reactance coils." E. A. CAROLAN. (The General Electric Co.) December 16th.

27,761. "Improvements in electric cut-outs." E. A. CAROLAN. (The General Electric Co.) December 16th.

27,762. "Improvements in electric condensers." E. A. CAROLAN. (The General Electric Co.) December 16th.

27,763. "Improvements in means for varying the voltage of alternating electric currents." E. A. CAROLAN. (The General Electric Co.) December 16th.

27,764. "Improvements in systems of electric phase transformation." E. A. CAROLAN. (The General Electric Co.) December 16th.

27,765. "Improvements in electric phase indicating instruments." E. A. CAROLAN. (The General Electric Co.) December 16th.

27,766. "Improvements in potential indicators for high voltage electric circuits." E. A. CAROLAN. (The General Electric Co.) December 16th.

27,767. "Improvements in electric arc lamps." E. A. CAROLAN. (The General Electric Co.) December 16th.

27,769. "Improvements in electric rheostat switches." E. A. CAROLAN. The General Electric Co.) December 16th.

27,770. "Improvements in electric arc lamps for constant potential circuits." E. A. CAROLAN. (The General Electric Co.) December 16th.

27,771. "Improvements in electro-magnetic locks for automatic electric circuit-breakers." E. A. CAROLAN. (The General Electric Co.) December 16th.

27,772. "Improvements in electric regulators." E. A. CAROLAN. (The General Electric Co.) December 16th.

27,773. "Improvements in compounding dynamo-electric machines." E. A. CAROLAN. (The General Electric Co.) December 16th.

27,785. "Improvements in devices for marking the scores in playing games on billiard tables, for indicating the names and relative positions of the players in handicap games, for printing the score of any player, for electrically transmitting the scores to distant places, and for simultaneously displaying advertisements." H. W. FAIRBRASS. December 16th.

27,786. "Improvements in insulating metallic surfaces or wires." J. A. HEANY. December 16th. (Complete.)

27,787. "Improvements in electric arc lamps." J. A. HEANY. December 16th. (Complete.)

27,802. "An improved manufacture of porcelain insulators and other hollow earthenware articles and apparatus therefor." F. M. LOCKE. December 16th. (Complete.)

27,820. "Improvements in trolley heads for overhead electric traction." F. KENNINGTON, T. W. KENNINGTON, D. L. FAWCETT, and L. FAWCETT. December 16th.

27,835. "Improvements in appliances for lighting electric trolley cars." E. A. HALL. December 17th. (Complete.)

27,838. "Improvements in and relating to electric lampholders." A. D. SMITH. December 17th.

27,849. "Improvements in appliances for use in connection with the electric lighting of railway and other vehicles and for electric lighting purposes generally." THE ELECTRIC AND ORDNANCE ACCESSORIES CO., LTD., E. C. ASTINGTON and R. F. HALL. December 17th.

27,850. "Improvements in and connected with the electric lighting of railway and other carriages and the like." R. F. HALL. December 17th.

27,858. "Improvements in electric light switches and the like." A. ECKSTEIN and A. J. D. KRAUSE." December 17th.

27,861. "Fan arc lamp." O. GROSS. December 17th.

27,883. "Improvements in solenoids." T. HAMILTON-ADAMS. December 17th.

27,887. Improvements in magneto-electric igniters for internal combustion engines." THE TANGYE TOOL AND ELECTRIC CO., LTD., and A. H. BATE. December 17th.

27,895. "Casing for supporting the effective iron rings of electrical machines." N. LASCHET. December 17th.

27,907. "Improvements in electric ignition apparatus for internal combustion engines." M. POGNON. December 17th.

27,933. "A pneumatic device to automatically actuate the starting rheostats of electro-motors driving organ-blowing apparatus." R. A. COUSANS and L. B. COUSANS. December 18th. (Complete.)

27,934. "Improvements in and connected with telephonic instruments." W. E. HEYS. (The Hutchison Acoustic Co.) December 18th. (Complete.)

27,995. "Improvements in swivelling trolley bases for electric street cars and other electrically-propelled vehicles." E. M. MUNRO, H. BRECKNELL and H. I. ROGERS. December 18th.

28,006. "Improvements in and relating to electricity meters." G. HOOKHAM. December 18th.

28,011. "An improved clutch for electric arc lamps." THE HON. R. T. D. BROUGHAM and F. S. WORSLEY. December 18th.

28,012. "Improvements in electrical switches." SIEMENS BROS. & Co., LTD., and A. S. CLIFT. December 18th. (Complete.)

28,013. "Improvements in negative electrodes for electric accumulators and in the method of forming them. THE CHLORIDE ELECTRICAL STORAGE CO., LTD. (La Societe Anonyme pour le Travail Electrique ces Metaux.) December 18th. (Complete.)

28,037. "Improvements in attaching telephone instruments in telephone boxes." T. TURNER. December 19th.

28,039. "Improvements in apparatus used as standards or brackets for gas or electric light." J. B. MORRALL. December 19th.

28,071. "Improvements in switches for alternating electric current systems." C. RIEDER. December 19th. (Complete.)

28,078. "A method for making electrical conductors from materials which are non-conductors or poor conductors." G. POMMERHANZ and H. WIEN. December 19th.

28,080. "Improvements in electric motor controllers." J. G. CHILDS. December 19th.

28,087. "Improvements in compensating friction in electric meters." F. P. COX. (Date applied for under Patents Act, 1901, January 22nd, 1902, being date of application in United States.) December 19th.

28,092. "Improvements in and relating to arc lamps." T. L. CARBONE. December 19th.

28,104. "Improvements in switches for double-filament electric lamps." L. LOBENTHAL and J. MCCULLOUGH. (Date applied for under Patents Act, 1901, May 22nd, under date of application in United States.) December 19th. (Complete.)

28,109. "An improved process for electroplating iron and steel." S. O. COWPER-COLES and COWPER-COLES INVENTIONS DEVELOPMENT CO., LTD.) December 19th.

28,167. "Improvements in electric systems of signalling for railways." H. G. BROWN. (Date applied for under Patents Act, 1901; October 10th, 1902, being date of application in United States.) December 20th. (Complete.)

28,170. "Improvements in or relating to telephone systems." F. STOCK. December 20th. (Complete.)

28,171. "Improvements in or relating to telephonic systems." F. STOCK. December 20th. (Complete.)

PUBLISHED SPECIFICATIONS, 1901.

Copies of any of these Specifications may be obtained of Messrs. W. P. Thompson and Co., 322, High Holborn, W.C., and at Liverpool, price, post free, 9d. (in stamps).

4,736. "Improvements in swivelling trolley heads employed in overhead wire electric traction." E. M. Munro, H. Brecknell and H. I. Rogers. Dated March 6th, 1901.

4,760. "Improvements in electric measuring instruments." A. Campbell. March 6th, 1901.

4,767. "An improved cable for supplying the electric current to electrically-driven ploughs and for like purposes." C. Meissner. Dated March 6th, 1901.

4,768. "An improved electric bell circuit for mechanically-driven ploughs." C. Meissner. Dated March 6th, 1901.

4,776. "An improved means for operating electric switches on sectional conductor electric railways." R. W. Barker. Dated March 6th, 1901.

4,777. "Improved electric switch mechanism for surface contact railways, and the like." R. W. Barker. Dated March 6th, 1901.

4,777A. "Improvements in electro-magnets." R. W. Barker. Dated March 6th, 1901.

4,810. "Improvements in electrolytic interruptors." F. de Mare. Dated March 6th, 1901.

4,819. "A new or improved device for connecting the trolley with the trolley wire in electrically-driven vehicles." H. J. Weintz. Dated March 7th, 1901.

4,820. "Improvements in switching apparatus for electric circuits." W. du B. Duddell and T. Mather. Dated March 7th, 1901.

4,822. "Improvements in arc lamps." J. S. Scott. Dated March 7th, 1901.

4,841. "Improvements in and relating to swivelling trolley heads employed in the overhead wire system of electric traction." H. E. F. Brecknell. Dated March 7th, 1901.

4,863. "Improvements in combined electro-magnetic and carbon microphone." W. E. Rossetter. Dated March 7th, 1901. (Patent not yet due for sealing.)

4,868. "Improvements in electric switches." C. W. Scott. Dated March 7th, 1901. (Date applied for under Sec. 103 of Patents, &c., Act, 1883, August 16th, A.D. 1900.)

4,870. "Improvements relating to electric couplings for railway cars." C. D. Abel. (Siemens & Halske Aktiengesellschaft.) Dated March 7th, 1901.

4,899. "Improvements in and relating to overhead wires and guard wires for electric traction and other purposes." H. R. Burnett. Dated March 7th, 1901.

5,017. "Improvements in electric batteries." G. Heidel. Dated March 9th, 1901.

5,038. "Improvements in incandescent electric lamps." Sir H. C. Mance and Nernst Electric Light. Dated March 9th, 1901.

5,039. "Improvements in preparation of Nernst conductors for electric lamps." C. C. Garrard and Nernst Electric Light. Dated March 9th, 1901.

5,040. "Improvements in Nernst incandescent electric lamps." C. C. Garrard and Nernst Electric Light. Dated March 9th, 1901.